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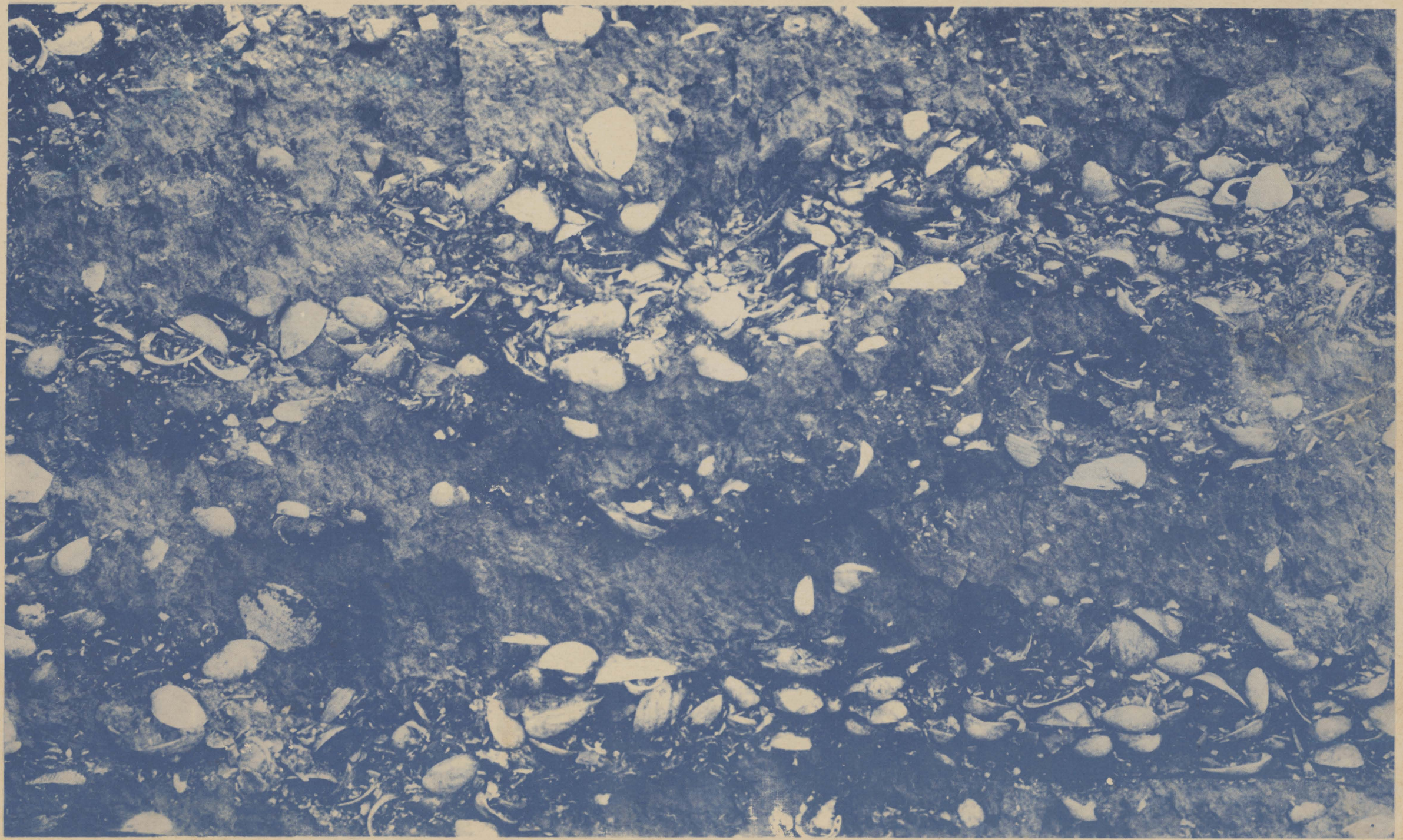
Preservation Planning Series

Sedimentary Studies of Prehistoric Archaeological Sites



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Preservation Planning Series

Sedimentary Studies of Prehistoric Archaeological Sites

Criteria for the identification of submerged archaeological sites of the northern Gulf of Mexico continental shelf

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Foreword

The Division of State Plans and Grants, National Park Service, provides technical assistance information for the activities of identifying, evaluating, and protecting historic and archaeological properties. Important technical problems affecting efficiency and effectiveness in carrying out these three activities are selected periodically for examination in the Preservation Planning Series.

Accelerated use of mineral resources on the continental shelf of the United States has brought a demand for practical techniques to protect submerged archaeological sites within the larger framework of environmental protection and economic development activities. The existing framework of environmental protection includes consultation with State Historic Preservation Officers about adequate management of the historic resources of their coastal zones, including those on the continental shelf. Although protection requirements apply equally to Federal activities on the continental shelf as well as on land, the open ocean clearly imposes physical and economic limitations which call for specialized resource protection strategies. Because of these constraints, historic preservation on the continental shelf usually is based upon avoidance. For example, pre-construction surveys identify locations whose probabilities of being an historic site are sufficiently great that mineral exploration and development are relocated voluntarily to avoid the suspected site. At the present time, positive identification of drowned habitation sites or of many shipwreck locations has not occurred because the avoidance option usually is employed in any suspicious situation.

However, reliance on the avoidance strategy also stems partly from the fact that practical techniques for identifying drowned habitation sites have not been perfected. "Sedimentary Studies of Prehistoric Archaeological Sites," by Sherwood M. Gagliano and his associates at Coastal Environments, Inc., outlines for the first time workable criteria for the identification of submerged archaeological sites on the northern Gulf of Mexico continental shelf. By use of conventional bottom sampling instruments, sediment samples from suspected archaeological habitation sites now can be examined against specific technical criteria, and a conclusion can be drawn about whether such sites in fact have been found.

Use of the manual will add significantly to the ability of Federal agencies and other users of the continental shelf environment to make reliable and discriminating decisions in the protection of drowned archaeological sites. These procedures also should serve as models for development of similar identification criteria for other continental shelf areas.

The Preservation Planning Series is prepared under the supervision of Marilyn P. Cable. Comments and suggestions on the technical information presented in this series are welcome. We appreciate the excellent work of Coastal Environments, Inc., in developing the analytical procedure reported here, as well as their willingness to undertake the printing of this manual.

Lawrence E. Aten
Chief, Division of State Plans and Grants
National Park Service
Washington, D.C. 20240
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CHAPTER I
INTRODUCTION

In the wake of the recent energy crises have come accelerated exploration and development of the mineral resources of the outer continental shelf (OCS) in the Gulf of Mexico as well as along the California, Atlantic, and Alaskan coasts. These increased extraction activities have emphasized the possibility of resultant irreversible damage to, and loss of, the cultural resources of the OCS, the drowned habitation sites of indigenous peoples and shipwrecks from the Historic period.

In recognition of possible damage to environmental and cultural resources resulting from activities of the mineral extraction industries, the U.S. Department of the Interior initiated several study efforts to inventory and evaluate the OCS environment, and in 1974 it implemented a requirement for marine archaeological surveys of all leased drilling sites.

The results of the preliminary study of the cultural resources potential of the northern Gulf of Mexico OCS have been published by the National Park Service (Coastal Environments, Inc. [CEI] 1977). In addition to an evaluation of historic shipwreck occurrence, this study demonstrated that, with current technology, a variety of submerged relict landforms likely to contain evidence of human occupation were identifiable and mappable on the OCS. Subsequent to the completion of this preliminary overview, numerous cultural resources surveys and evaluations of lease blocks, pipeline rights-of-way, and other construction projects have been conducted in the offshore area of the northern Gulf of Mexico (Figure 1-1). Most of these surveys have utilized geophysical techniques, primarily marine proton magnetometers, fathometers, side-scan

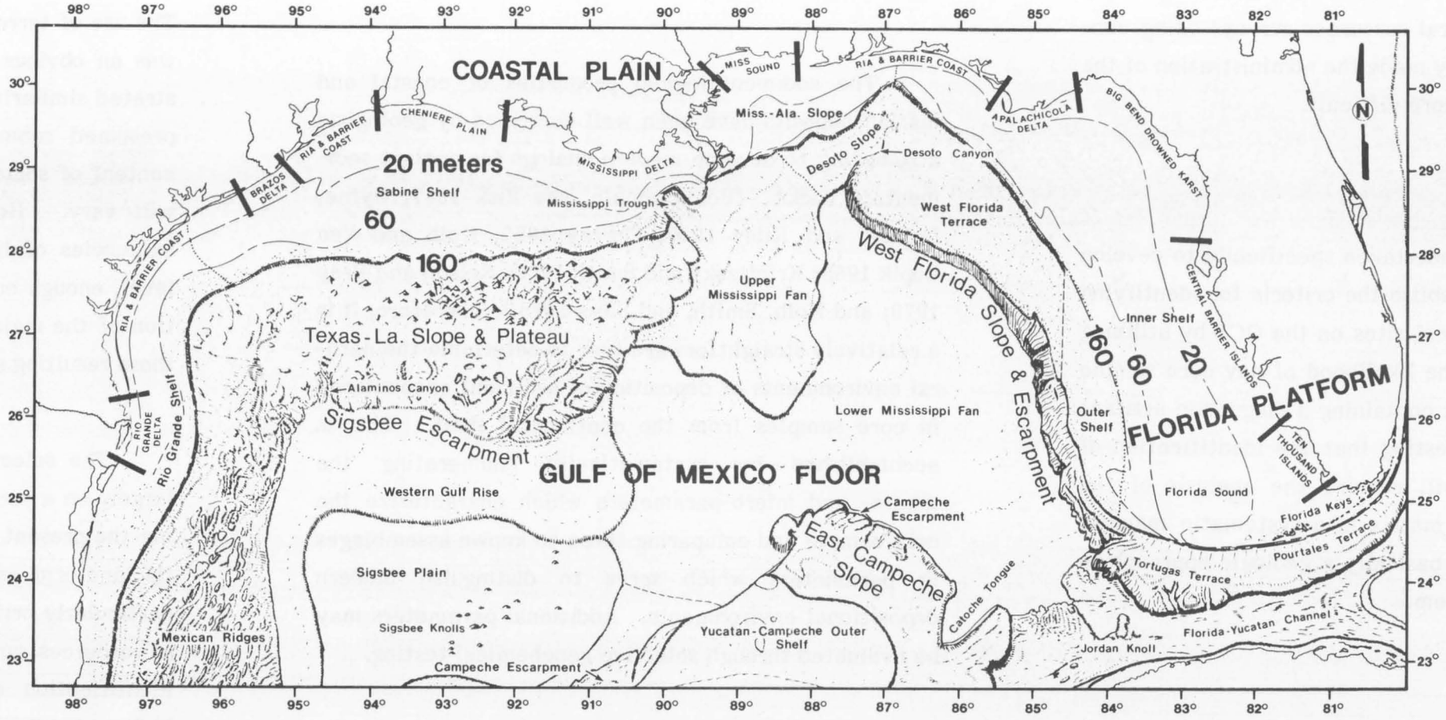


Figure 1-1. *Active coastal systems, physiographic divisions, and bathymetry of the northern Gulf of Mexico (modified from Bergantino 1971 and Brooks 1974).*

sonars, and various types of sub-bottom profilers. In instances where submerged landforms likely to contain evidence of human occupation have been identified, some surveys have included physical testing of the bottom deposits with small-diameter gravity cores. The retrieved core samples have been studied in the laboratory by archaeologists to determine if any indications of human activity are present. This has proved to be a challenging and, with few exceptions, an unrewarding exercise, primarily because there is presently little framework of reference with which to compare the core data. Despite the technical ability to identify high-probability landforms, the lack of a formalized approach to verify prehistoric archaeological deposits, should they exist on these landforms, has limited the usefulness of the cultural resources surveys being conducted and has certainly made the administration of the resources of the OCS more difficult.

This study was undertaken specifically to develop the procedures and establish the criteria for identifying prehistoric archaeological sites on the OCS by utilizing core-sized samples. The likelihood of any core sample from a cultural deposit containing a diagnostic artifact is extremely low, suggesting that the identification of archaeological sites will require the analysis of the complete core sample matrix in a systematic manner. The situation calls for basically a geologic approach to an archaeological problem.

The approach is based upon the premise that characteristics of sedimentary rock reflect the kind and intensity of processes active during deposition as well as those which have influenced the rock after deposition. Stated in another way, processes may be recorded in the rock record. They are recorded in the physical and chemical make-up of the sediment and may be interpreted from such characteristics as bedding, mineral composition, chemical alterations, sorting of size of individual particles, color, and inclusions. The sedimentologist has learned to read the record of processes through systematic study of these and other characteristics. Further, it has been demonstrated that assemblages of sedimentary characteristics may be used to identify specific kinds of depositional environments. Depositional environments, in turn, may be related to modern counterparts in active coastal and marine systems.

The sedimentological properties of coastal and marine deposits have been well described by geologists attempting to develop modern analogs for ancient sedimentary rocks. (For example, see Fisk 1947; Byrne, LeRoy, and Riley 1959; Curray 1960; Kolb and Van Lopik 1966; Krinitzsky and Smith 1969; Nelson and Bray 1970; and Kolb, Smith, and Silva 1975.) Therefore, it is a relatively straightforward task to determine the natural environments of deposition of sediment encountered in core samples from the continental shelf. This is accomplished by systematically enumerating the macro- and micro-parameters which characterize the core sample and comparing these to known assemblages or parameters which serve to distinguish modern depositional environments. Additional parameters may be evaluated through selective geochemical testing.

The demonstrated ability of these analytic procedures to identify and discriminate among natural deposits and processes suggests their applicability to the analysis of deposits derived from cultural processes. Presumably, cultural processes leave marks in the sedimentary record which are distinct from those produced by entirely natural processes. The processes involved in site formation should make site deposits distinct and identifiable even in the absence of obvious artifacts.

The approach developed for the project consisted of extracting a series of core-size samples from selected onshore prehistoric archaeological sites and subjecting them to a series of standardized sedimentological and geochemical analyses designed to identify and define the parameters characteristic of cultural deposits. The use of terrestrial site analogs in pursuing this study was an obvious necessity despite the lack of demonstrated similarities between known terrestrial sites and presumed submerged ones. Obviously the material content of societies widely differing in time and space will vary. However, it can be assumed that the exigencies of human existence will produce, at some level, enough commonalities to permit the differentiation of the majority of culturally derived deposits from those resulting solely from natural processes.

The selection of sites to be sampled was based largely on a series of practical considerations concerning the present condition and knowledge of the site and its landform association. The latter consideration is particularly critical since the implementation of cultural resources survey coring on the OCS is based on the identification of specific landforms presumed to be high-probability areas for site occurrence. A detailed discussion of site selection is provided later in this chapter.

geological considerations

Perhaps the most fundamental consideration in the study of drowned terrestrial sites is that great areas of the continental shelf were exposed as land areas during relatively recent geological times, but have become submerged as a result of sea level change (Figure 1-2). While there is probably a consensus among Quaternary geologists that most of the continental shelf areas of the world were exposed as a result of worldwide glacial episodes during the interval from about 20,000-17,000 years ago, there is still considerable disagreement as to absolute depth below present level of this low sea stand. In the northern Gulf area there is currently evidence of submerged shoreline features active during this interval to depths of at least 90 m. As a result of recent geological studies conducted on the western shelf area by the U.S. Geological Survey (USGS), Dr. Henry Berryhill, project director, places the Wisconsin low stand at approximately 130 m (personal communication 1980).

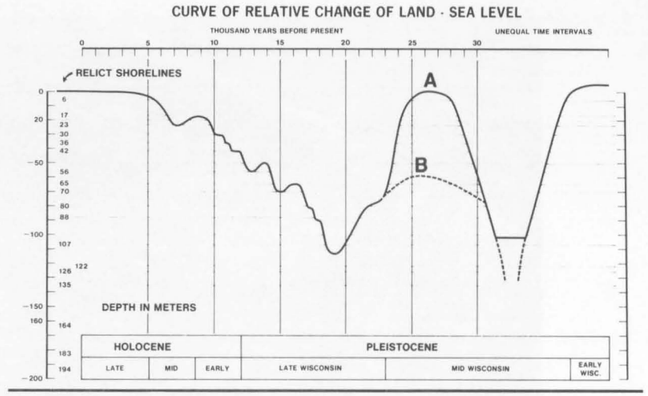


Figure 1-2. *Curve of relative land-sea level for the northern Gulf of Mexico. Curve derived from data from various published sources which include: Coleman and Smith 1954; Schnable and Goodell 1968; Rehkemper 1969; Nelson and Bray 1970; Frazier 1974; CEI 1977.*

The second fundamental consideration is whether or not human populations were present in the region during intervals of terrestrial exposure. It is not unreasonable to assume that man has been present in the region for 20,000 years or more (Figure 1-3). Therefore, virtually the entire shelf has some potential for drowned terrestrial sites.

A third consideration is whether or not archaeological deposits on the shelf could have survived the

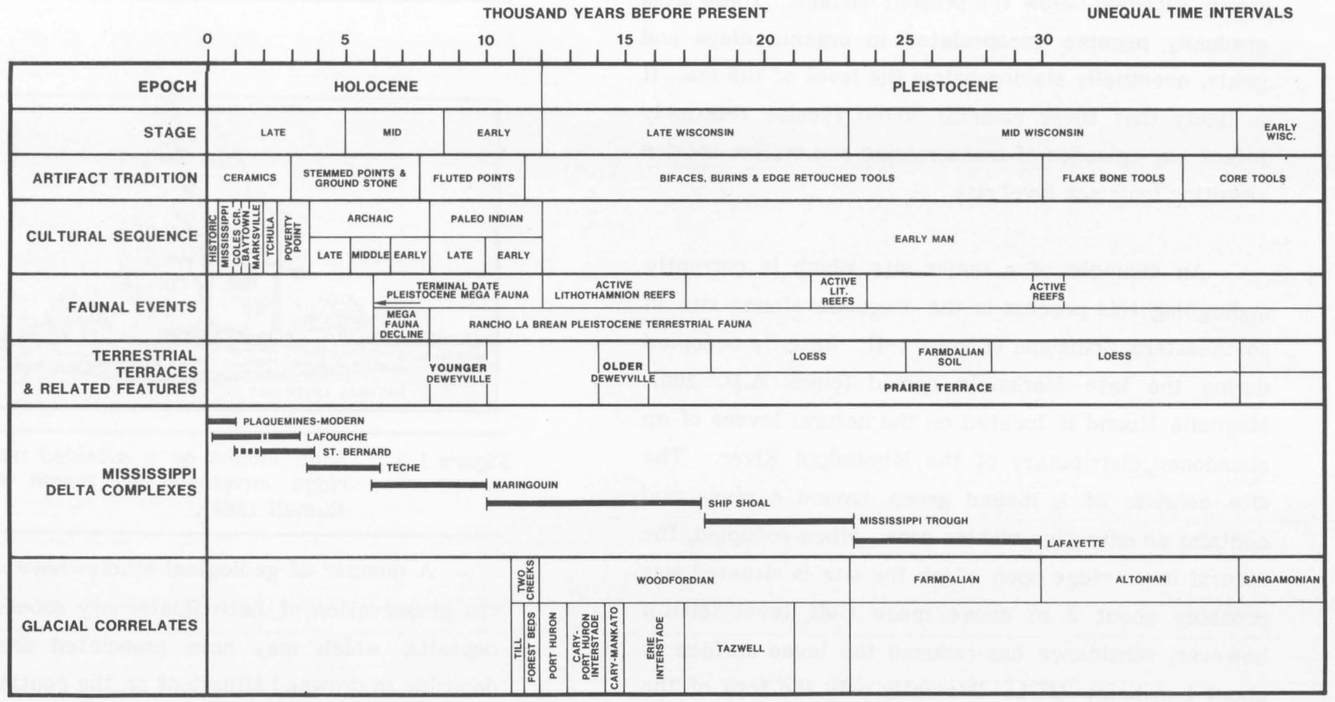


Figure 1-3. *Late Quaternary events and cultural sequence (modified from CEI 1977).*

Late Wisconsin transgression. Many researchers contend that most sites that may have existed on the shelf have been destroyed by marine erosion during periods of transgression. There is evidence, however, which indicates that in certain areas a significant portion of the total number of drowned sites may survive periods of transgression. (It should be noted that even reworked archaeological materials have important information value, particularly when considered from a geographic perspective.)

Numerous examples of completely and partially buried and drowned sites are known from the Mississippi Deltaic Plain. These sites are located on landforms which, since their initial prehistoric occupation, have slowly subsided below the present surface. These sites gradually became encapsulated in organic clays and peats, eventually sinking below the level of the sea. It is likely that these remains would survive relatively intact any episodes of transgression and marine erosion resulting from sea level rise.

An example of a major site which is currently undergoing this process is the Magnolia Mound site in southeastern Louisiana (Figure 1-4). Initially occupied during the late Marksvile period (circa A.D. 200), Magnolia Mound is located on the natural levees of an abandoned distributary of the Mississippi River. The site consists of a mound group around a plaza and contains an extensive midden area. When occupied, the natural levee ridge upon which the site is situated was probably about 2 m above mean Gulf level (MGL); however, subsidence has reduced the levee surface to about 1 m below MGL. Presently only the tops of the mounds and the crests of the natural levee ridges stand above the surface of the brackish marsh (Figure 1-5).

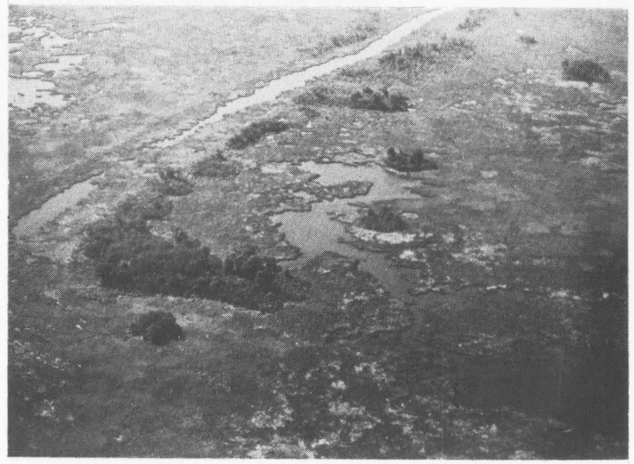


Figure 1-4. *Aerial view of the Magnolia Mound site (16 SB 49). Note abandoned distributary channel in background.*

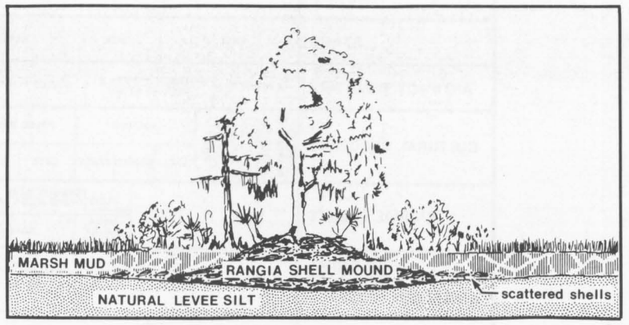


Figure 1-5. *Shell mound on a subsided natural levee ridge enveloped by marsh mud (after Russell 1967).*

A number of geological studies have documented the preservation of Late Quaternary subaerial coastal deposits, which may have associated archaeological deposits, in drowned situations on the continental shelf. A good example of such evidence is provided in a study conducted by Nelson and Bray (1970) of Holocene sediments from the Sabine River trench in the East Texas shelf area. Using a combination of sub-bottom profiles, bathymetry, and cores, these researchers have defined the three-dimensional geometry of estuarine deposits filling the former river trench, as well as shallow marine transgressive deposits which blanket the sea floor above the filled trench (Figures 1-6 and 1-7). They have also interpreted the environments of deposition of the various strata within the section and established their age through radiocarbon dating (Figure 1-8). Nelson and Bray (1970:48) interpret the sequence as follows:

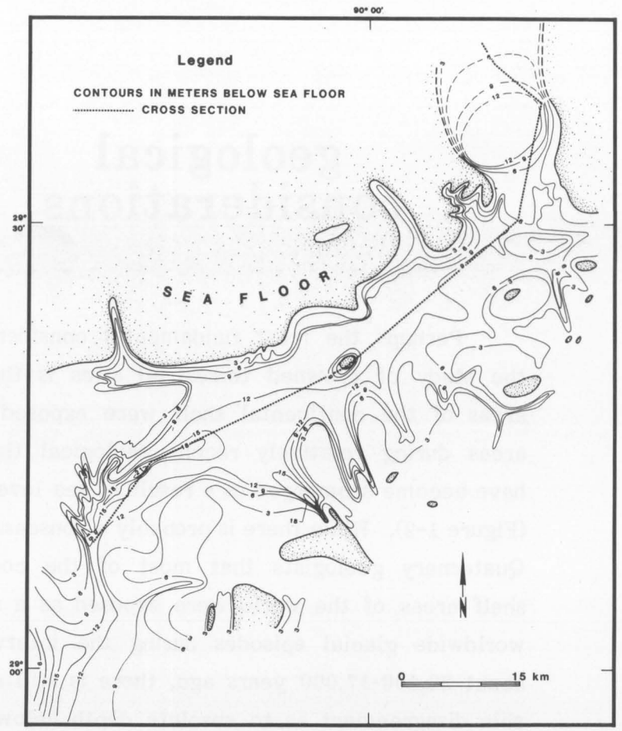


Figure 1-6. *Contour map showing configuration of top of Pleistocene Beaumont Clay and top of basal sand in filled channel of the Sabine River (after Nelson and Bray 1970).*

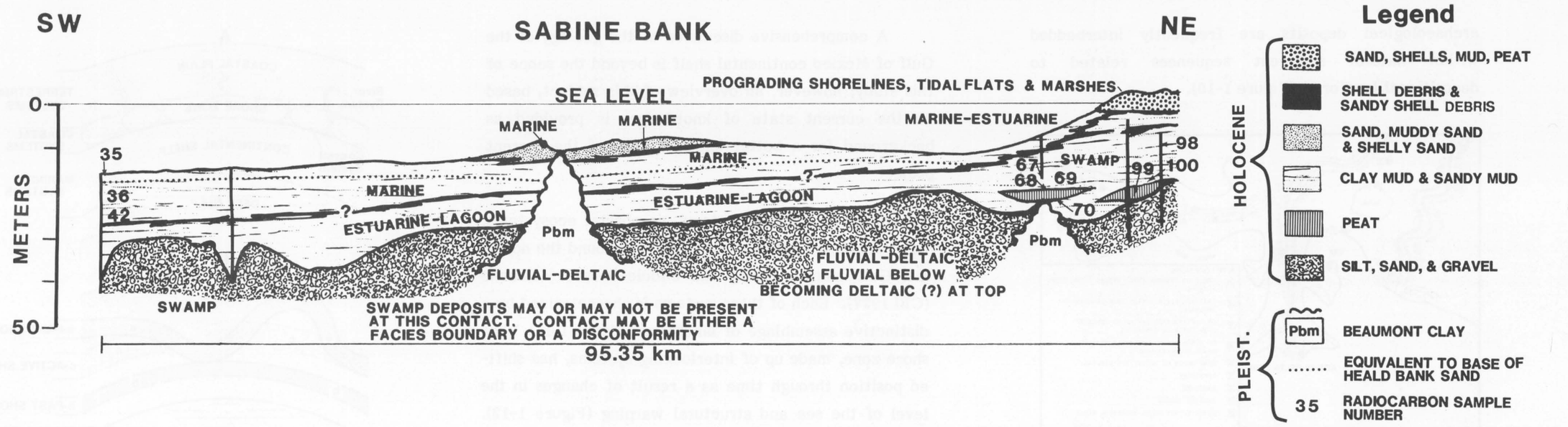


Figure 1-7. *Cross section showing stratigraphy of Holocene sediment along axis of buried channel of former Sabine River. Location of section shown in Figure 1-6 (after Nelson and Bray 1970).*

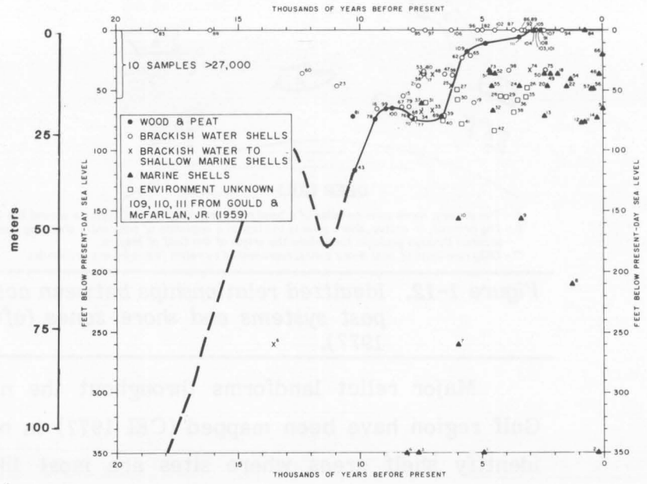


Figure 1-8. *Graph showing radiocarbon dates from samples of deposits associated with Sabine River trench fill. The curve shows the inferred rise of the Holocene sea in the area (after Nelson and Bray 1970).*

Data developed...trace the Holocene history in the Sabine Trench from 10,200 years B.P. to the present. Prior to this time fluvial sedimentation was filling the glacial stage river valleys. At 10,200 years B.P. the rising sea began to flood the Sabine valley and convert it into a lagoon or estuary. A swamp formed ahead of the rising water. At this time sea level was at -117 feet. The sea continued to rise rapidly until it reached a level of -73 feet at 9,400 years B.P. when the rate of rise decreased. For the next 2,800 years, until 6,600 years B.P., sea level fluctuated between -62 and -72 feet. Sand began to accumulate along a shoreline just south of the study area during this time. At 6,600 years B.P. sea level again began to rise rapidly; this continued until 5,650 years B.P. when the rate of rise decreased. Sea level reached its present elevation approximately 2,800 years ago. Important geologic events during this period were: (1) inundation of the upland, (2) the change from a brackish water to a marine environment in the vicinity of the banks (5,200+ years B.P.), (3) accumulation of sand in the marine environment to form present-day Heald and Sabine Banks, and (4) establishment of the shoreline on the coastal plain and migration of part of this shoreline seaward as the Sabine estuary filled with sediments.

This study has established that subaerial deposits associated with a river mouth estuary active during Paleo Indian and Archaic times are preserved in the shallow subsurface on the continental shelf. As river mouth estuaries are known to have been favored habitation places for prehistoric people, it is reasonable to assume that archaeological sites may be associated with the buried river trench, its margins, and fill.

A fourth fundamental consideration essential to this study concerns the relationship between sites and landforms. In active coastal zones, the pattern of settlement and environmental use is closely related to natural systems and associated landforms. For example, in the Mississippi Delta system prehistoric settlement and environmental use patterns are intimately related to the distribution of natural levees and shorelines (Figure 1-9). In similar fashion, models can be developed depicting man-land relationships for most coastal systems. Further, at the intrasite level,

archaeological deposits are frequently interbedded within natural sediment sequences related to depositional landforms (Figure 1-10).

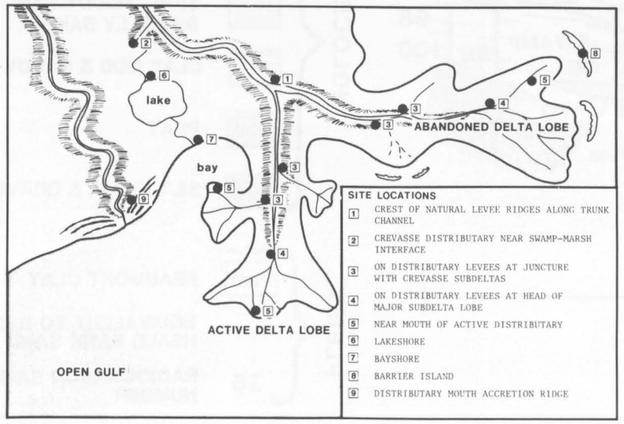
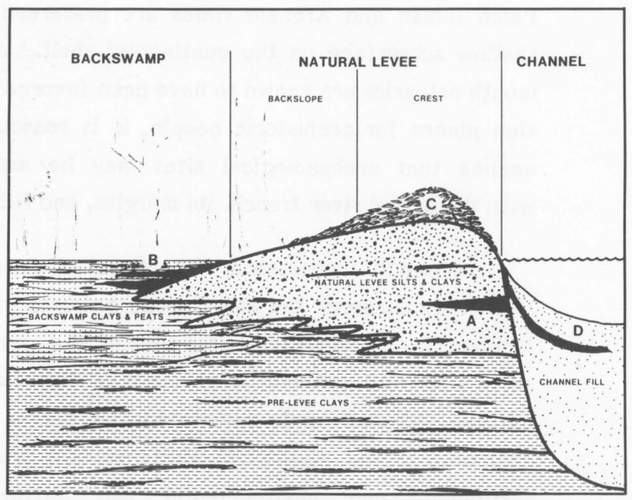

lake
bay
ABANDONED DELTA LOBE
ACTIVE DELTA LOBE
OPEN GULF
SITE LOCATIONS
1 CREST OF NATURAL LEVEE RIDGES ALONG TRUNK CHANNEL
2 CREVASSE DISTRIBUTARY NEAR SWAMP-MARSH INTERFACE
3 ON DISTRIBUTARY LEVEES AT JUNCTURE WITH CREVASSE SUBDELTAS
4 ON DISTRIBUTARY LEVEES AT HEAD OF MAJOR SUBDELTA LOBE
5 NEAR MOUTH OF ACTIVE DISTRIBUTARY
6 LAKESHORE
7 BAYSHORE
8 BARRIER ISLAND
9 DISTRIBUTARY MOUTH ACCRETION RIDGE

Figure 1-9. *Preferred prehistoric site locations in the Mississippi Deltaic Plain.*



A - Midden deposits interbedded with natural levee sediment.
B - Midden deposits interbedded with backswamp clays and peats.
C - Archeological deposits on natural levee surface.
D - Archeological deposits interbedded with channel fill deposits.

Figure 1-10. *Association of archaeological deposits with natural levee and related deposits.*

A comprehensive discussion of the geology of the Gulf of Mexico continental shelf is beyond the scope of this study; however, an overview of this subject, based on the current state of knowledge, is provided as background for a better understanding of the current project.

Thirteen natural systems, or coastal ecosystems, have developed within the shore zone around the northern Gulf margin during the middle-to-late Holocene (CEI 1977). Each of these systems is characterized by a distinctive assemblage of landforms (Figure 1-11). The shore zone, made up of interlocking systems, has shifted position through time as a result of changes in the level of the sea and structural warping (Figure 1-12). Relict features associated with formerly active coastal systems can be identified both on the coastal plain, landward of the present shore zone, and on the continental shelf seaward of the present shore zone. These relict landforms may be thought of as skeletal elements of relict coastal systems and they provide clues for reconstruction of former coastal systems, shoretrends, and, indirectly, for identification of high-probability areas for prehistoric site occurrence.

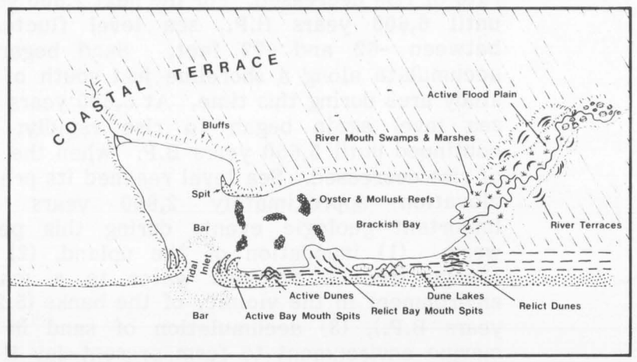
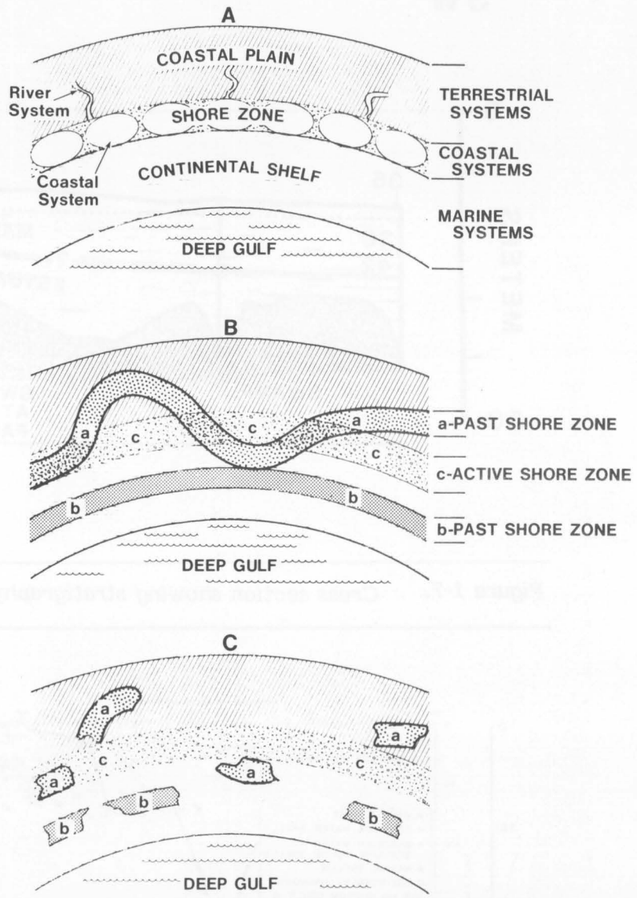


Figure 1-11. *Idealized barrier spit and bay system showing typical arrangement of physiographic units.*



A - The present shore zone consists of a band of interlocking coastal systems around the Gulf margin.
B - The present, or active, shore zone is the last in a sequence of constantly changing positions that have occured through geologic time since the origin of the Gulf of Mexico.
C - Only remnants of past shore zones, represented by relict features, are preserved.

Figure 1-12. *Idealized relationships between active and past systems and shore zones (after CEI 1977).*

Major relict landforms throughout the northern Gulf region have been mapped (CEI 1977) in order to identify shelf areas where sites are most likely to occur. This has been accomplished through synthesis of published and unpublished data, as well as through interpretation of bathymetric maps and geophysical data resulting from offshore surveys. The most current map of these relict shelf features is provided as Figure 1-13.

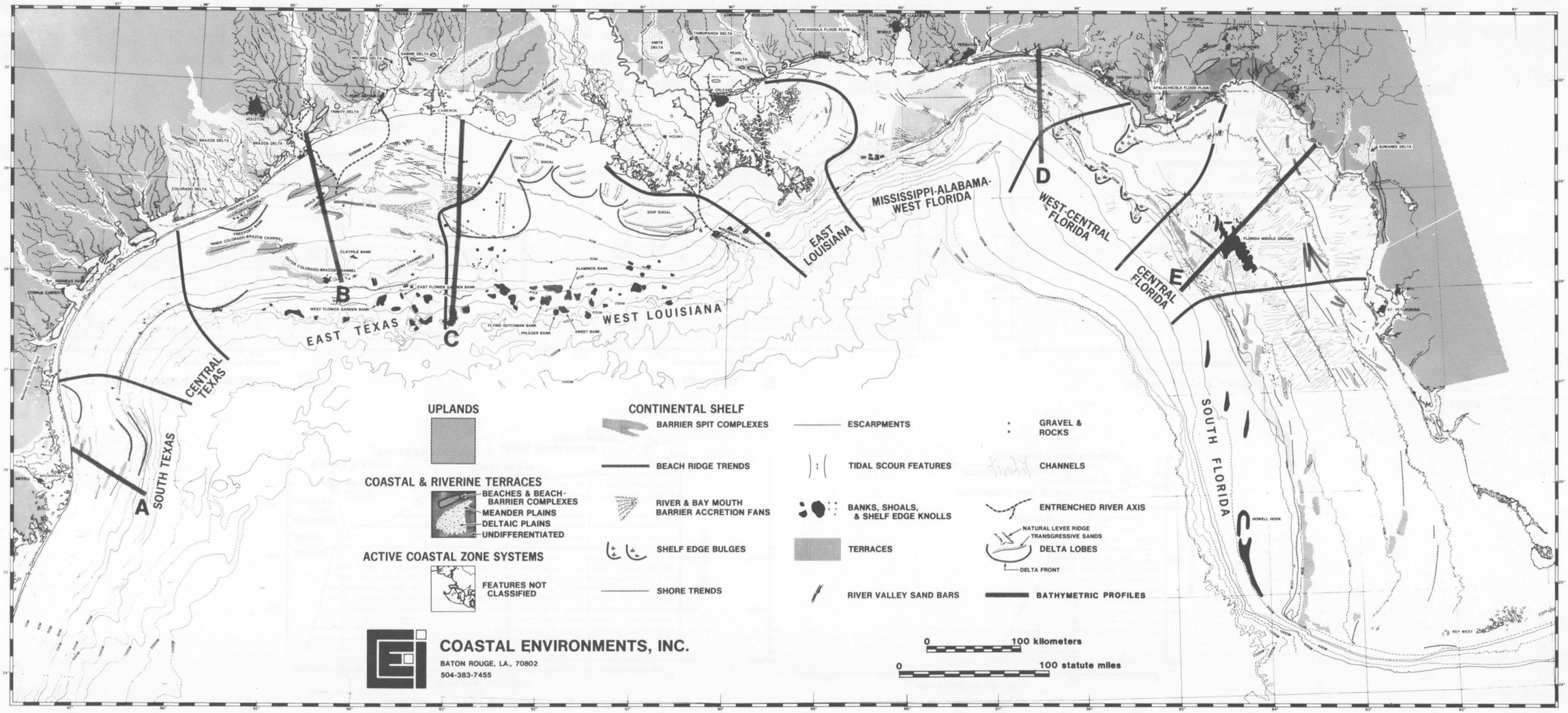


Figure 1-13. *Relict geomorphic features of the coastal terraces and continental shelf, northern Gulf of Mexico (modified from CEI 1977).*

One aspect of the recent work has been an attempt to estimate the relative age of relict features through the use of bathymetric profiles. Figure 1-14 presents bathymetric sections from various areas along the shelf. Note the great variation in shelf width and the repeated occurrence of relict shore zone features at specific levels.

Projecting these levels to a curve of relative change of land and sea level (Figure 1-2) allows the placement of these relict shore zones in their proper time perspective. This curve illustrates several other important points. There has been major disagreement among Quaternary geologists regarding the so-called "Mid-Wisconsin" high sea stand, illustrated in Figure 1-2 by the difference between curves A and B. There is a growing body of data supporting a high stand, probably only 1 or 2 m below the present level, during the interval from about 28,000-25,000 B.P. (For example see Curray 1965; Milliman and Emery 1968; Schnable and Goodell 1968; Frazier 1974; Field et al. 1979; Sirken and Stuckenrath 1980) The curve also illustrates variations in rate of change (Figure 1-2). During the Late Quaternary sea level rise, with which researchers are most concerned, there have been intervals of rapid rise, intervals of slow rise or relative stillstand, and intervals of reversal. It is during the intervals of stillstand and reversal that coastal systems become complex and chances for preservation of archaeological deposits are optimum.

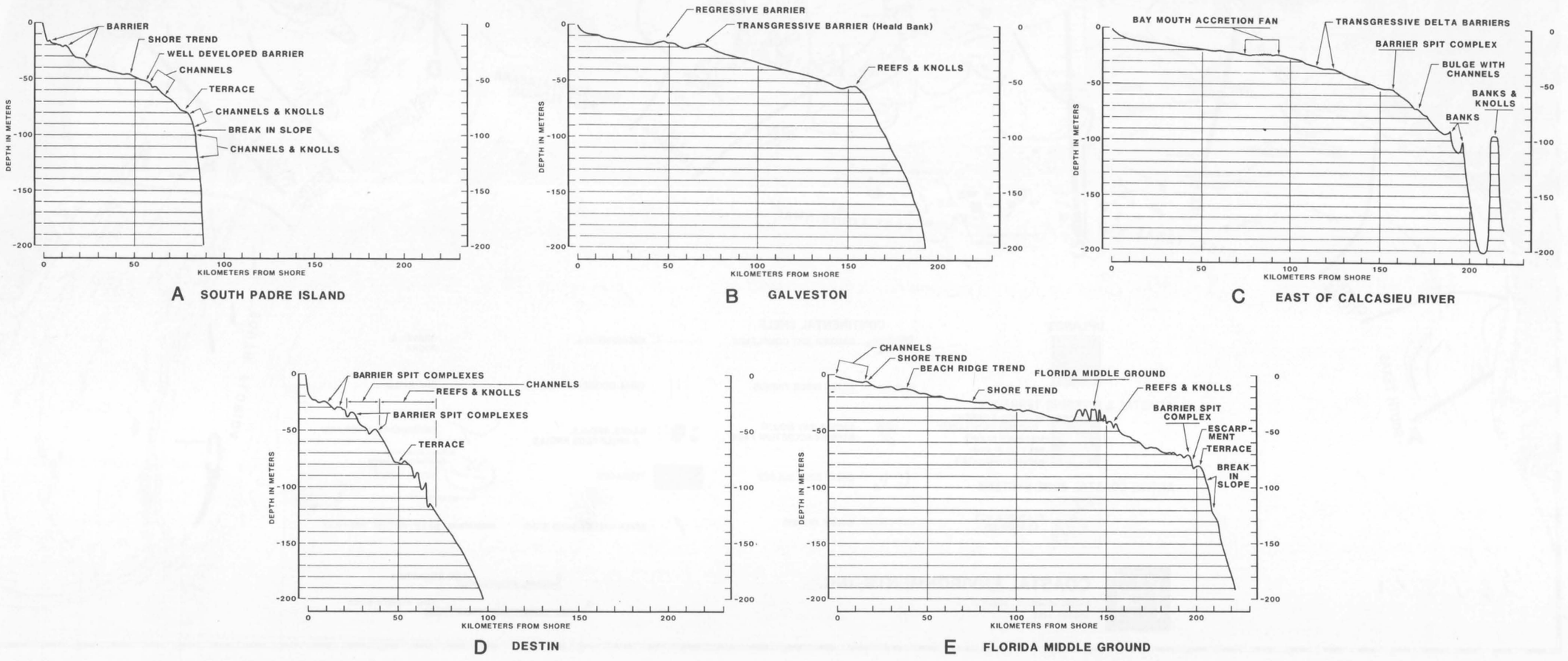


Figure 1-14. Selected bathymetric profiles across the continental shelf of the northern Gulf of Mexico. Locations shown in Figure 1-13. (Compare to relative land-sea level curve, Figure 1-2).

The East Texas-West Louisiana shelf area is one where relict landforms related to former coastal systems are exceptionally well developed and preserved, and it is used to illustrate some aspects of the current state-of-the-art for identifying and evaluating offshore prehistoric terrestrial sites. In the deep water of this area (60-120 m) are relict features which define former shore zones, including banks, shoals, escarpments, and barrier spit complexes. Closer to the shore are delta lobes, filled and unfilled channels, and well-developed beach and shore trends. Of particular interest is a section which crosses an accretion fan complex and a relict delta lobe of the Mississippi River (Figure 1-15, section X-X').

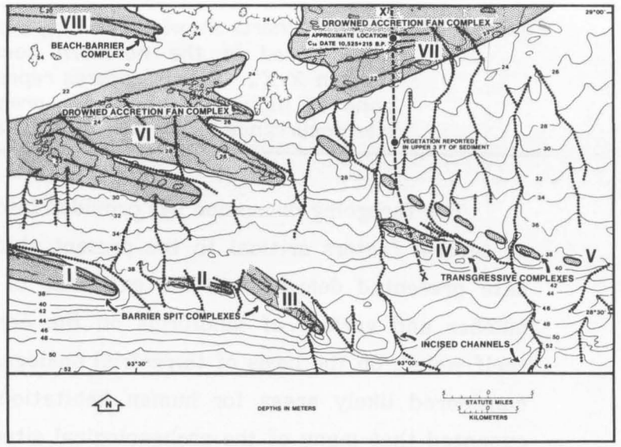


Figure 1-15. *Relict geomorphic features on the sea floor in the East Texas-West Louisiana shelf area. Roman numerals indicate relative age of features.*

Geological and geophysical data have been obtained along this section as a result of pipeline surveys (Gagliano 1978). This information includes sub-bottom profiles, side-scan sonar records, and shallow gravity cores. In addition, a radiocarbon determination obtained from a wood and brackish water peat sample gives some indication of the age of the shore trends. The date from this material is 10,525± 215 years B.P. (Frazier 1974).

The major surface features identified along the section are a prominent drowned accretion fan complex and a transgressive sand complex overlying the relict Mississippi Delta lobe. Hard, dry, brown clay at the surface in two areas along the section indicated exposures to subaerial weathering at some time in the past.

A cross section drawn from sub-bottom profile data and shallow cores (Figure 1-16) indicates that the upper 50 m of the section consist of well-stratified deposits. Bedding characteristics and overall geometry indicate a deltaic sequence shown as units A, B, C, and D. Some time after deposition, these deltaic deposits were subaerially exposed, weathered, and incised by streams. The incised area is filled by a sequence interpreted as channel, bay, and reef deposits (Unit E). This is a good depiction of an estuarine sequence. Unit F is interpreted as progradational mudflat deposits and is overlain by Unit H, deposits of the accretion fan complex. Unit G is a transgressive sand complex which was also subaerially exposed.

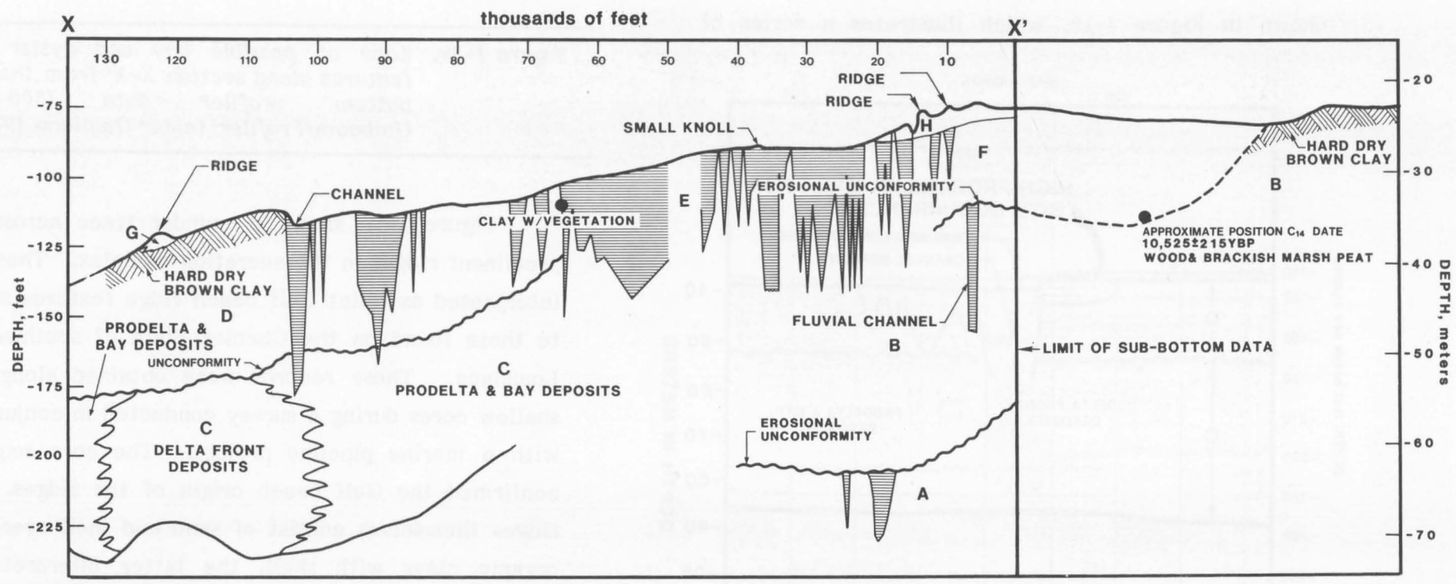


Figure 1-16. *Interrelationships between sedimentary units and relict geomorphic features on the East Texas-West Louisiana shelf. Data from previous pipeline surveys. Location of section shown in Figure 1-15 (after Gagliano 1978).*

Within this section are a number of areas considered to have a high potential for prehistoric site occurrence. Among these are the margins of the incised bay, the transgressive sand units, the oxidized surfaces, and the accretion complex. Based on terrestrial analogs, these all represent relict landforms which would have provided favorable habitation locales for prehistoric populations.

An example of sub-bottom profile records obtained for this section is shown in Figure 1-17. These records were obtained with a 300 Joule Uniboom/Profiler. In the upper unit are seen well-defined fluvial channels, the pronounced erosional surfaces, and the characteristics of the estuarine sediment. Another example of the estuarine unit is shown in Figure 1-18, which illustrates a series of features interpreted as shell reefs or islands that probably formed within a shallow bay. It can be anticipated that large shell middens would have acoustical characteristics similar to these reefs.

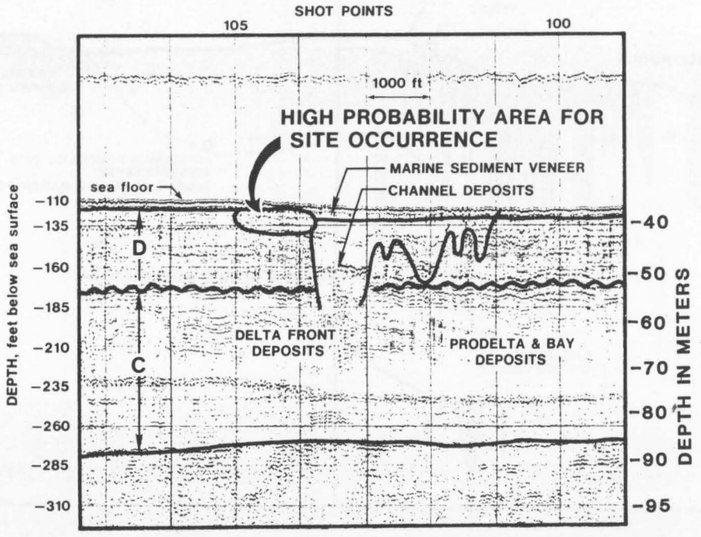


Figure 1-17. *Annotated segment of sub-bottom profile record (300 Joule Uniboom/Profiler) along section X-X' showing high-probability zone for prehistoric site occurrence in Unit D (after Gagliano 1978).*

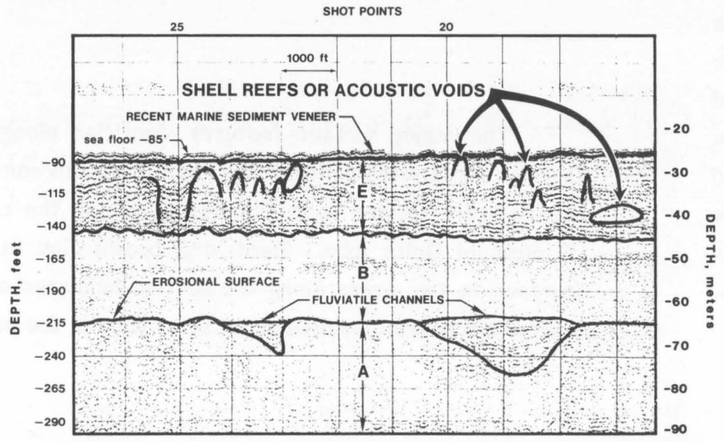


Figure 1-18. *Zone of possible bay and oyster reef features along section X-X' from the sub-bottom profiler data (300 Joule Uniboom/Profiler) (after Gagliano 1978).*

Figure 1-19 shows a sounder trace across two prominent ridges in the accretion complex. These are interpreted as relict Gulf beach ridge features similar to those found on the Chenier Plain of southwestern Louisiana. These records were obtained along with shallow cores during a survey conducted in conjunction with a marine pipeline project. The core sequence confirmed the Gulf beach origin of the ridges. The ridges themselves consist of sand and shell overlaying organic clays with shell, the latter interpreted as mudflat and marsh facies. Both the geometry and sedimentary characteristics are very comparable to those of onshore ridges in southwestern Louisiana; however, it should be noted that the sand and shell facies has been reworked and is capped with marine shells. Although the cores confirmed the geological interpretation and the fact that the landforms may have been suitable for human occupation, no evidence of human process was found.

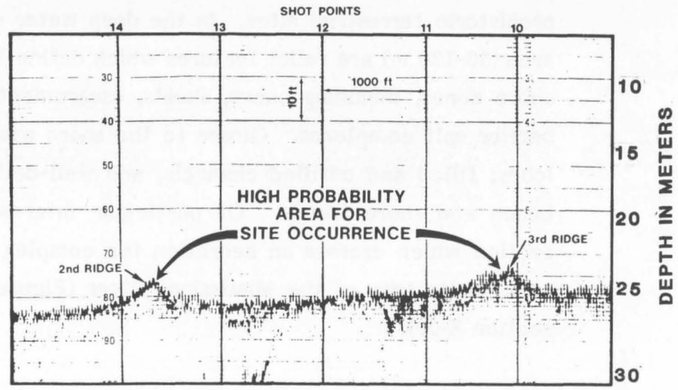


Figure 1-19. *Sounder charts showing two ridge features encountered in the northern sector of section X-X'. These features represent a zone of high probability for prehistoric site occurrence (after Gagliano 1978).*

The foregoing discussion has provided information on several factors critical to the present study. The data presented demonstrate the existence of a large number and variety of landforms on the continental shelf which, on the basis of terrestrial analogs, may be considered likely areas for human habitation. It is expected that many of the archaeological sites associated with these landforms have been preserved in whole or in part. Additionally there is currently available an array of geophysical techniques which can provide information necessary to accurately map shelf features, pinpoint locations considered likely to yield archaeological remains, and to sample these remains. The identification of archaeological sites from these samples, the concern of this study, is the next logical step in the appraisal of cultural resources on the OCS.

selection of the site sample

A total of 15 terrestrial sites were selected for study from the coastal areas of Mississippi, Louisiana, and southeast Texas (Figure 1-20). Site selection was dependent upon several qualifications concerning site/landform relationships: 1) the site must be associated with a landform type which is identifiable and mappable on the continental shelf using current technology; 2) the site must be commonly and consistently associated with that type of landform; and 3) the site must be so situated that there would be a probability of its being preserved on the continental shelf.

With these criteria in mind, eight terrestrial coastal landform types upon which prehistoric sites were known to occur were selected for study as analogs: 1) natural levees of major streams in a subsiding delta, 2) natural levees of minor streams in a subsiding delta, 3) chenier and accretion ridges, 4) barrier islands, 5) salt dome margin, 6) estuarine margin, 7) relict channel on a Pleistocene terrace, and 8) coastal lake margin.

One to four sites from each landform category were investigated (Table 1-1). The actual choice of sites depended primarily on pragmatic considerations, including the site's location. An additional consideration was the availability of information about the site, especially contour maps and stratigraphic profiles. The sites selected were not meant to be a random sample of Gulf coast sites. Indeed, such a sample would be undesirable. Rather, sites were selected which would be reflective of the kinds and range of site situations likely to be encountered, preserved, and discoverable on the continental shelf.

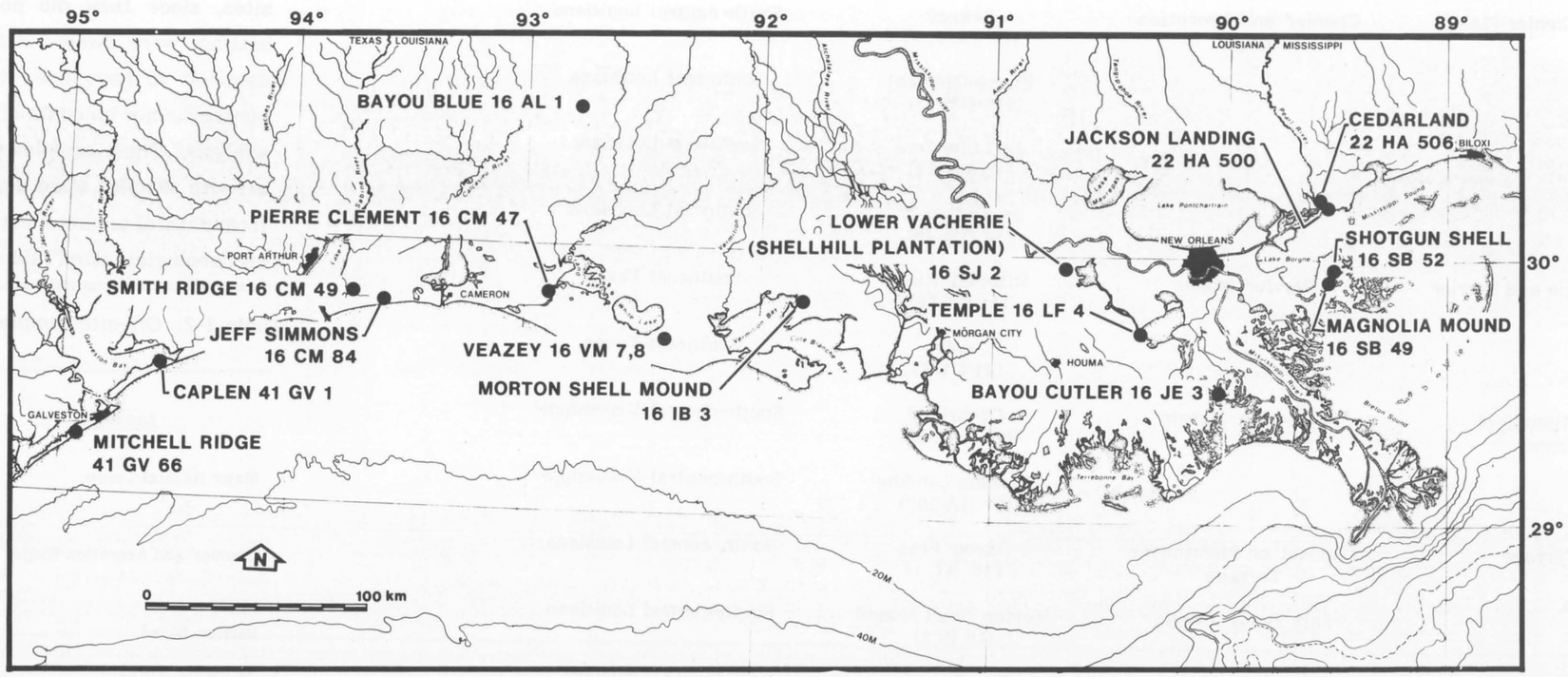


Figure 1-20. *Distributions of prehistoric sites sampled as terrestrial analogs.*

Table 1-1. Archaeological sites selected as terrestrial analogs.

COASTAL SYSTEM	LANDFORM	SITE AND NUMBER	LOCATION
Delta	Major Natural Levee	Bayou Cutler (16 JE 3)	Southeast Louisiana
		Magnolia Mound (16 SB 49)	Southeast Louisiana
	Minor Natural Levee	Shotgun Shell (16 SB 52)	Southeast Louisiana
		Lower Vacherie Mound (16 SJ 2)	Southeast Louisiana
Chenier Plain	Chenier and Accretion Ridge	Veazey (16 VM 7, 8)	South-central Louisiana
		Pierre Clement (16 CM 47)	Southwest Louisiana
		Jeff Simmons (16 CM 84)	Southwest Louisiana
		Smith Ridge* (16 CM 49)	Southwest Louisiana
Ria and Barrier	Barrier Island	Mitchell Ridge (41 GV 66)	Southeast Texas
		Caplen (41 GV 1)	Southeast Texas
Mississippi Sound	Estuarine Margin	Cedarland (22 HA 506)	South-central Mississippi
		Jackson Landing (22 HA 500)	South-central Mississippi
Terrace	Channel on Pleistocene Terrace	Bayou Blue (16 AL 1)	South-central Louisiana
	Salt Dome Margin	Morton Shell Mound (16 IB 3)	South-central Louisiana
Delta	Lake Margin	The Temple (16 LF 4)	Southeast Louisiana

*Also on minor natural levee.

One intent of the project was to make subjective comparisons between the results of the analysis of samples taken from the sites and information about known natural environments described in the existing sedimentological literature. However, it was also felt that more objective comparisons should be attempted. In order to accomplish this, it was necessary to collect and analyze off-site samples in the same manner as the site samples.

Off-site samples were taken from the landform feature associated with the site. In several cases, however, the landform upon which the site was originally located had subsided and was no longer expressed at the surface. The off-site samples taken at these sites, since they did not reflect the true landform setting, were discarded from analysis. Other samples assumed to have been taken off-site were found to contain minor amounts of cultural material during later analysis. These samples also had to be discarded. The off-site samples were augmented by two samples taken from natural environments not associated with a nearby archaeological site (Table 1-2).

Table 1-2. Off-site samples taken from natural environments.

Landform	Off-Site Samples	
Major Natural Levee	16 SB 49	#2
	16 SB 49	#3
	No site association	
Chenier and Accretion Ridge	16 VM 7, 8	#2
	16 CM 84	#1
	16 CM 49	#3
Barrier Island	41 GV 1	#1
Estuarine Margin	22 HA 500	#1
Channel on Pleistocene Terrace	16 AL 1	#2
Oyster Reef	No site association	

field procedures

Similar field procedures were followed at each of the 15 sample sites. Matrix samples were obtained using a 15x20x8 cm stainless steel Senckenberg box (Bouma 1969:308-310) referred to below as a "box core." The coring device has one open end and is fitted with a removable lid (Figure 1-21).

This simple coring device has many advantages. It is strong enough to be driven into even well-consolidated deposits with a hammer and still yield undisturbed volumetric samples. Samples obtained can be conveniently transported to the laboratory without removal from the box, and since they are easy to orient before collecting, rather complete investigations can be carried out.

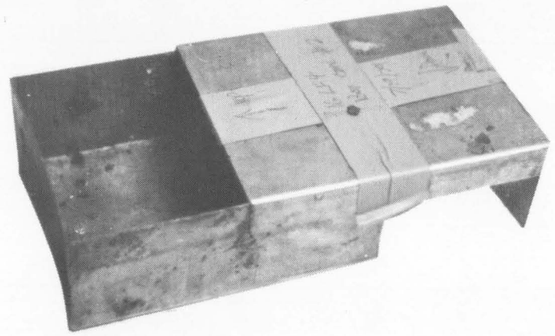


Figure 1-21. *The Senckenberg box utilized for core sampling during the present study.*

In order to avoid excavation of pits to obtain stratigraphic profiles, existing exposures were sought wherever possible. These included cutbanks along streams, eroded faces of large middens, and previous archaeological excavations. The sampling locale was determined by the location of such features. Only where no existing exposure was available were small pits opened in the deposit. One box core was taken if the deposit was shallow or uniform in composition (Figure 1-22). Two box cores were taken if significantly varying strata were observed (Figure 1-23). Prior to retrieval of the box core, the stratigraphy of each exposure was carefully drawn and photographed in a series from bottom to top (Figure 1-24).

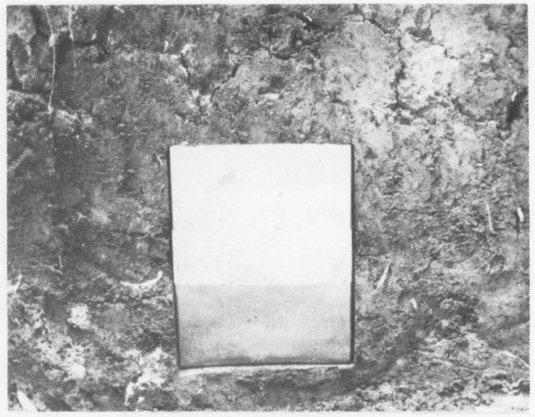


Figure 1-22. *Box core in place in wall of profile at Mound B, Magnolia Mound site (16 SB 49).*

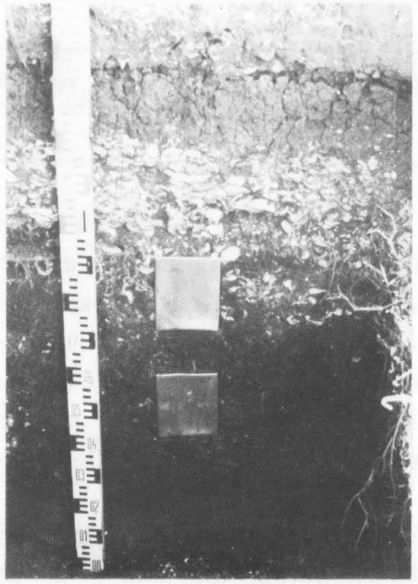


Figure 1-23. *Two box cores in wall of profile at the Lower Vacherie (Shellhill Plantation) site (16 SJ 2). Note varying strata.*

Figure 1-24. *Photographically recording the cleared profile face at the Morton Shell Mound (16 IB 3).*

Two to three samples for geochemical and grain size analysis were also taken from within the site area, and the same number were taken from outside the site boundaries. Geochemical samples were obtained by shoveling soil from the surface of the site into a sample bag after cleaning off the top few centimeters to remove vegetation and litter.

The geochemical samples taken from outside of the site boundaries comprised the off-site samples. These were analyzed in the same manner as the box core and on-site geochemical samples and provided the natural landform control against which site samples were compared.

organization of the volume

A major intent of this study was to produce a volume which, in addition to its scientific content, would serve the archaeological community as a guidebook to the procedures required to treat and analyze core samples. In line with this, an attempt has been made to present each level of analysis in the order in which treatment of an unknown core sample or set thereof should most logically proceed--that is, from the largest scale analysis requiring no specialized equipment or facilities to the smallest scale analysis requiring such equipment and facilities.

Efficiency suggests that a site/nonsite decision should be made at the highest analysis level possible. A simplified flow chart of the decision-making process is presented in Figure 1-25. As can be seen in the flow chart, if, at the end of all steps in analysis site indentification is equivocal, the sample is relegated to the nonsite category.

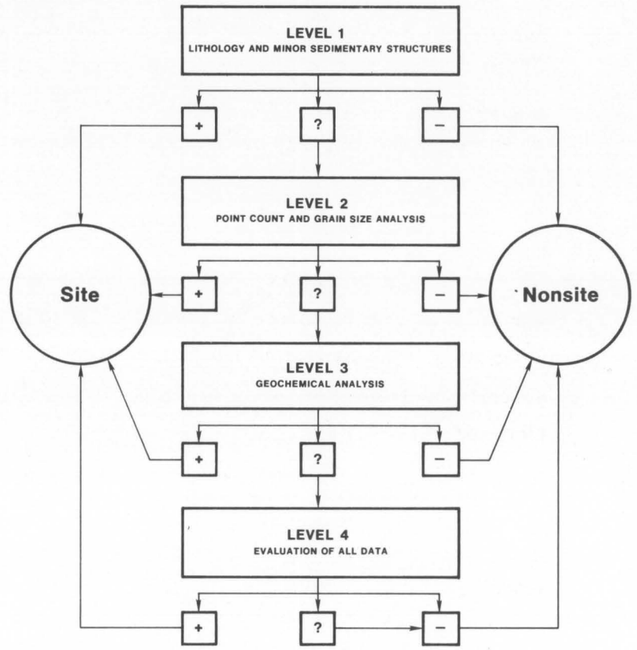


Figure 1-25. *Level of data analysis and decision-making pathways.*

LEVEL I

Lithology includes those characteristics of an outcrop (or, in this case, a long core of several meters)

which are subjected to megascopic examination, for example, the gross morphology and composition of the section and the presence or absence of bedding and its gross morphology and composition. These characteristics are described in Chapter III with reference to profiles from the 15 analog sites chosen for the study. The structures are discussed in terms of typical site depositional sequences and the cultural and natural processes which produced them. While gravity cores taken from continental shelf deposits generally will be of insufficient length to view these gross morphological features, continuous cores obtained with a drilling rig or vibra-coring tool may be obtained in some instances.

Minor sedimentary structures are those which would be visible in a core of 25-100 cm length. Minor structures, inclusions, and other macro sediment characteristics from the site samples are discussed in Chapter III.

LEVEL 2

Grain size analysis and point count analysis address the actual components of small-volume samples. A series of tables and graphs in Chapter IV presents comparisons of grain size distributions and point count data from site and off-site samples, with discussions of the significance of various components as site indicators. Statistical analyses provide more objective estimates of the likelihood that a sample is site-derived based on the presence of various components and show the degree to which sites and nonsites can be distinguished.

LEVEL 3

Geochemical analysis of selected site and off-site samples (Chapter IV) provided several chemical indicators of sites. Because the subsample subjected to geochemical analysis did not reflect the total range of sites in the sample (let alone the total universe of sites), the chemical data cannot always be expected to produce a definite answer despite the rather clear-cut results obtained in this study. A sample which remains equivocal at this level passes to the next level, an overall evaluation of the evidence.

LEVEL 4

It is anticipated that many potential sites will have to be considered at Level 4. At this level, all of the evidence is examined for consistency of interpretation. A sample which remains equivocal after passing through all of these levels of analysis will necessarily have to be placed in the nonsite category. Some sites on the continental shelf will undoubtedly defy all attempts at identification if no actual artifacts are encountered. This methodology, however, is aimed at maximizing the archaeologist's ability to recognize submerged sites in the absence of artifacts and without extensive examination of the deposit.

CHAPTER II: THE SITE SAMPLE

In this chapter, 15 sample terrestrial sites will be described, representing the eight drowned landforms on the OCS that can be identified by current technology and can be expected to contain cultural material. These eight landforms are: major natural levee, minor natural levee, chenier and accretion ridges, barrier island, salt dome margin, estuarine margin, channel on the Pleistocene terrace, and lake margin.

The 15 terrestrial sites chosen for this study are located within the Gulf coastal plain, between south-central Mississippi on the east and southeast Texas on the west. This region was selected because it provides almost all of the terrestrial landform analogs to those expected on the OCS. Only sites associated with sink holes in karst areas are not represented in this area.

It should be noted that specific features occuring in the site sample, such as pyramidal mounds, are unlikely to exist at sites on the OCS. Depsite this, the 15 sites selected are expected to exhibit the range of types of depositional characteristics found at continental shelf cultural deposits.

Each sample site will be discussed individually by landform association. The presentation is primarily graphic, utilizing numerous maps, cross sections, and photographs to convey site-landform relationships and the site composition. A limited amount of text is offered when it is considered conducive to providing site information. References relating to specific sites are omitted from the text and listed after each site discussion.

Some of the illustrative techniques warrant discussion. The area map provided for each site is overlayed with squares representing three-mile lease blocks. Off-shore mineral exploration occurs within such a size block, and therefore it was felt that this form of illustration would provide the reader with the appropriate perspective with which to view specific landforms and site features. In addition, surrounding lease-block-size squares, represented by dashed lines, are offered so one may acquire an understanding of how many blocks must be examined before the total site-landform situation becomes clear. On the area maps, furthermore, features exposed above surface are shown by solid lines while those presently submerged are represented by dashed lines. The location of subsided features was determined by reviewing known geological data, infrared aerial photographs, and surface trends which may indicate buried landforms. Known archaeological sites in the near vicinity of the site under discussion are indicated.

The cross sections offered with each site were derived by examining topographic maps and known geological deposits of similar features. In many instances borings and subsurface data are not available and the subsided features shown on the illustrations represent merely the best estimate as to the true subsurface situation.

sample acquisition

Field work at most sites was completed by preparation of a contour map showing the location of the profile and samples. In some cases, a contour map was already available, and the location of the profile and samples were drawn onto it in the field. Where possible, all on-site and off-site sample locations are shown on the maps accompanying site discussion. In some instances, the off-site samples were obtained from areas just outside the map boundary and cannot be depicted. The general region from which these samples come can be identified by studying both the area and site maps.

Similar field procedures were followed at each of the 15 sites sampled. This involved the collection of one or two (dependent on site size) "box" core samples from in situ midden matrix of each site and several shovel samples of midden from various locations within each site. These samples served to provide information on site content, stratigraphy, and structure.

Additionally, several shovel samples of soil matrix (off-site samples) were taken from outside the site boundaries at each site location. These were analyzed in the same manner as the box core and on-site geochemical samples and provide the natural landform analog against which site samples were compared. A complete discussion of analytical procedures employed is presented in Chapter IV.

major natural levee

Perhaps one of the earliest scientific observations concerning archaeological sites in coastal Louisiana was that the majority could be found on either subaerial or subsided natural levees of the numerous rivers and bayous which flow through the region (Kniffen 1936). Sites were located near the crests of the natural levees, usually along the cutbank side of meander loop cutoffs, at junctions of tributaries and distributaries, and/or along crevasse distributaries. Similar landform configurations can be identified on the OCS by either bathymetry or sub-bottom profiles. For the present study, two sites, Bayou Cutler I (16 JE 3) and Magnolia Mound (16 SB 49), were chosen as representatives of sites on the levees of a major crevasse distributary.

BAYOU CUTLER I (16 JE 3)

The Bayou Cutler I site is located atop the submerged natural levee of the Bayou des Familles-Barataria Crevasse distributary, a major channel initially emanating from the Mississippi River while the

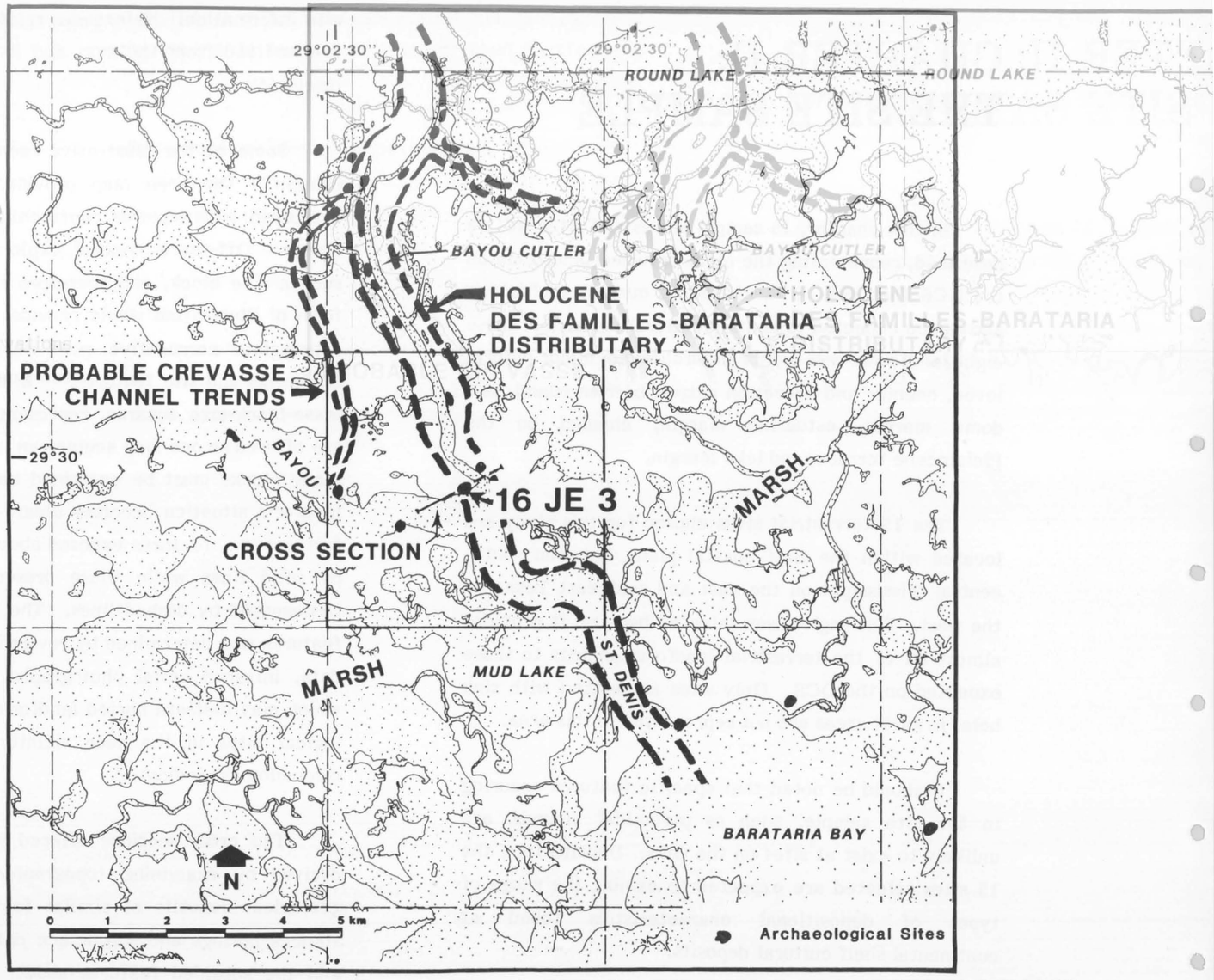


Figure 2-1. *Bayou Cutler I (16 JE 3) and other nearby prehistoric sites overlaid by hypothetical three-mile square lease blocks. Note the probable course of the des Familles-Barataria Crevasse channel.*

latter was building the St. Bernard Delta lobe (circa 1400-1 B.C.). Today, Bayou Cutler I occupies this ancient distributary channel. The channel, although submerged in the vicinity of the site, can still be identified on infrared aerial photographs and by the levee-flank depressions which parallel the old course. A sub-bottom profile would have little problem recording a similar configuration on the OCS.

Bayou Cutler I is an intermediate-sized shell midden and mound site which currently measures about 88 m long by 39 m wide. The site was more extensive in the past; however, recent gas-well dredging activities and the creation of the Barataria Waterway have removed large portions of it. The site may have once contained three shell and earth mounds, although only one, about 2 m high, exists today. Borings indicate the shell midden extends an additional 1 m below MGL.

The shell midden is composed of various levels of Rangia and Crassostrea shells. In the lower levels, a Rangia midden layer is interbedded with natural levee deposits, indicating initial site occupation during the progradation stage of the des Familles-Barataria distributary. Burials have been noted from the upper Rangia levels.

Bayou Cutler I was initially inhabited very early in the Marksville period (circa A.D. 1-100). Later archaeological cultures represented include Baytown, Coles Creek, and Plaquemine. Unfortunately, no concerted excavation has occurred at the site and little else is known about it.

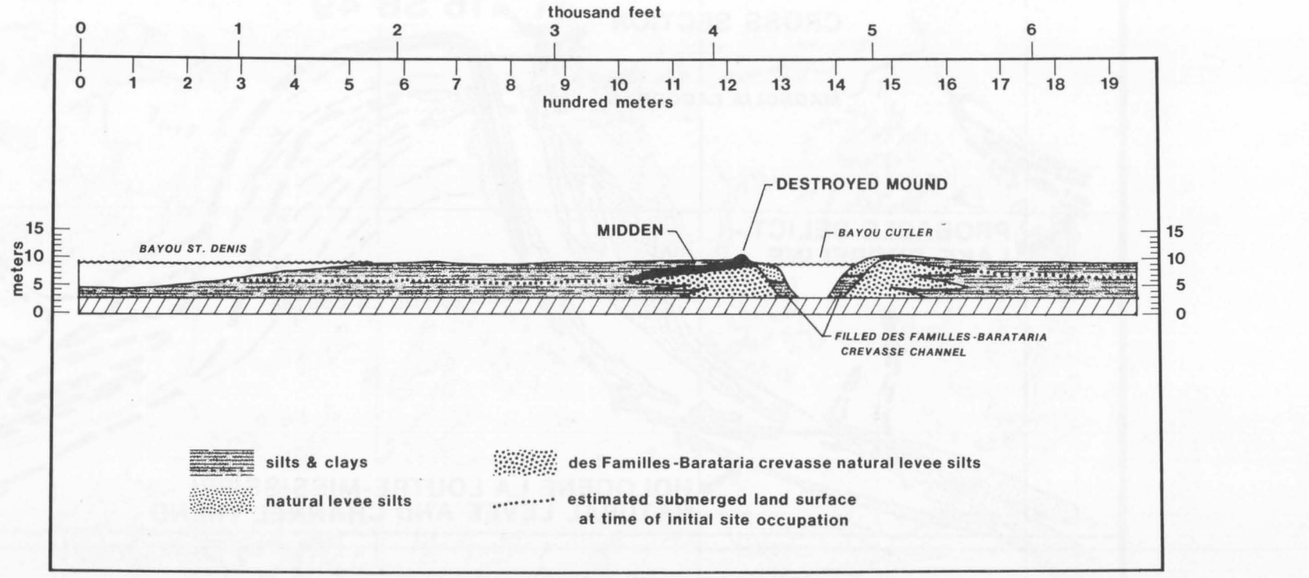


Figure 2-2. *Cross section through the Bayou Cutler I site (16 JE 3) illustrating its position on the des Familles-Barataria natural levee. Location of section shown in Figure 2-1.*

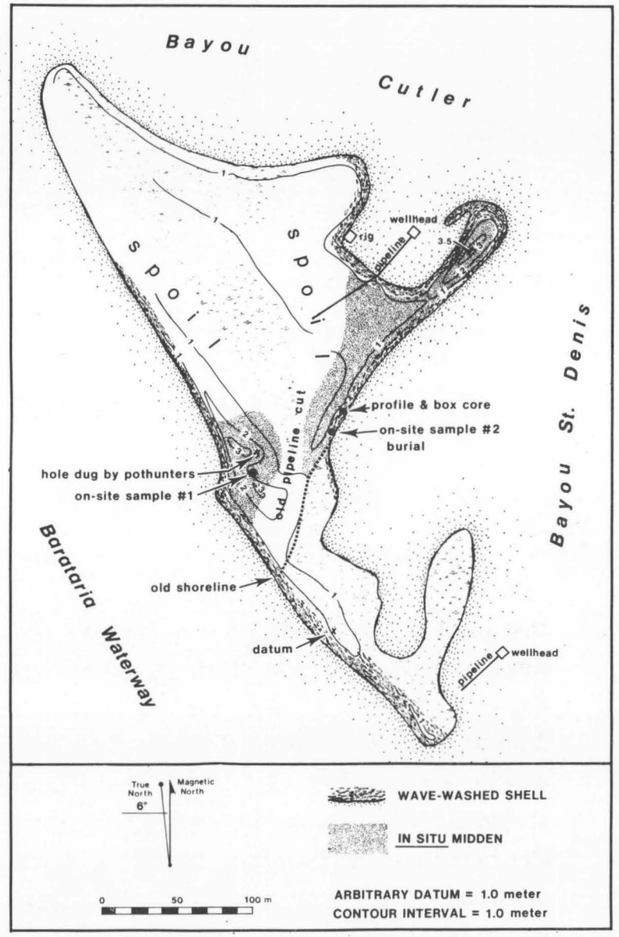


Figure 2-3. *The Bayou Cutler I site (16 JE 3), showing location of profile, box core, and on-site geochemical samples.*

References:

Kniffen 1936; McIntire 1958; Phillips 1970; Gagliano et al. 1979.

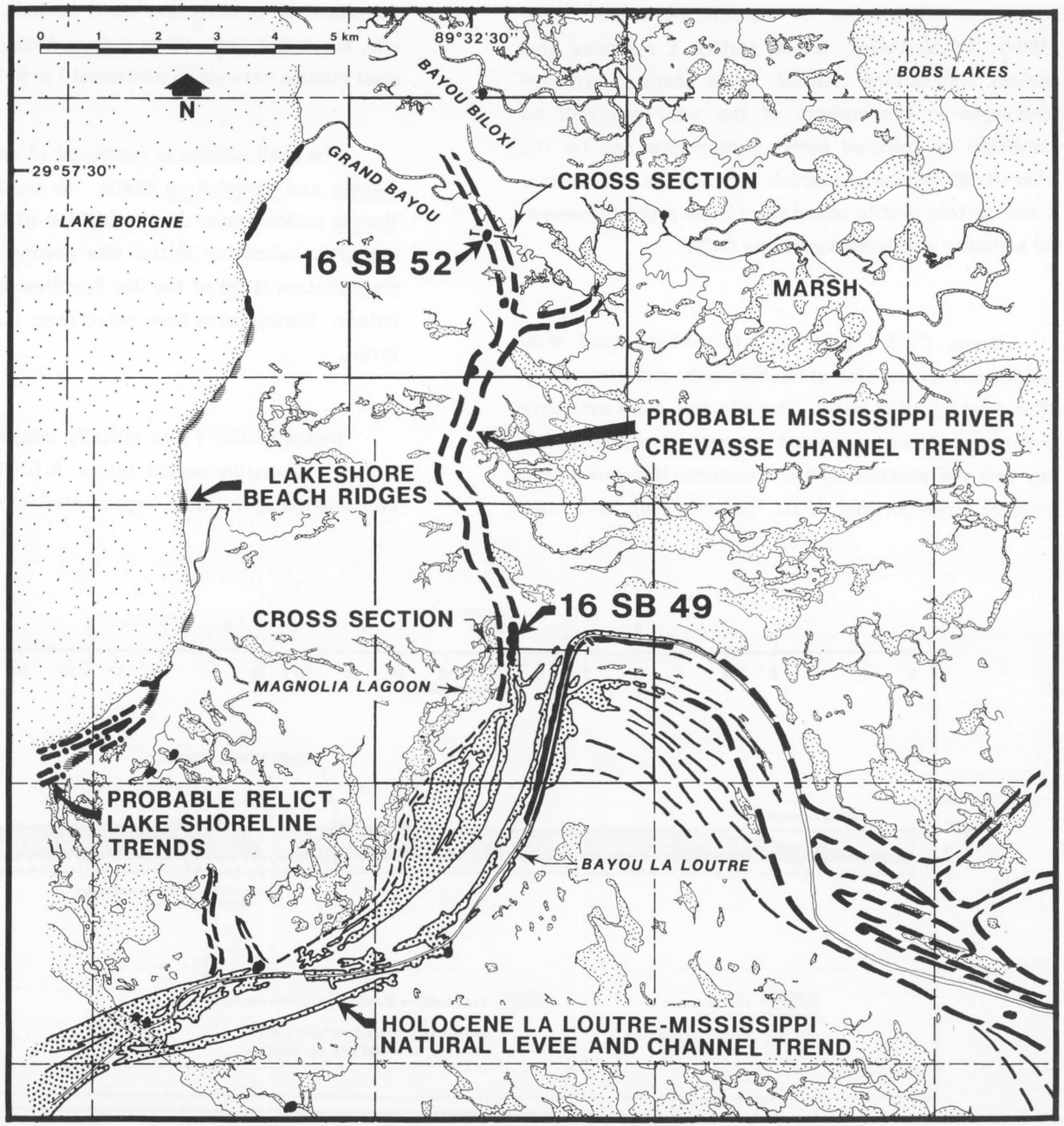


Figure 2-4. *Locational map of the Magnolia Mound (16 SB 49) and Shotgun Shell (16 SB 52) sites. Note the crevasse channel on which both sites are believed to be situated.*

MAGNOLIA MOUND (16 SB 49)

The Magnolia Mound site is the largest site examined during the present study. It consists of a group of at least 11 earth and shell mounds, both conical and pyramidal, and extensive areas of Rangia and black earth middens. The site measures 1.1 km long by 300 m wide, and attains a height of 3.4 m above MGL at the summit of the largest "Magnolia Mound." At least 1 m of known midden lies below ground surface, though midden depth is likely to be greater in some areas.

This impressive series of mounds and middens is located along the west bank of the Magnolia Crevasse channel, at one time a large distributary crevasse emanating from the big bend of the La Loutre-Mississippi (circa 1000-300 B.C.). Presently, because of subsidence, only the mounds and scattered portions of the natural levees of both the La Loutre-Mississippi and Magnolia Crevasse remain above marsh level. In the site vicinity, these occur as narrow bands on either side of Magnolia Crevasse. To the west lies Magnolia Lagoon, a feature offering evidence of a long levee-flank depression running parallel to the La Loutre-Mississippi levees. The modern channel of Bayou La Loutre, a small underfit stream occupying the older La Loutre-Mississippi Channel, is located east of the site.

Initial site occupation is believed to have occurred after the Mississippi had abandoned its La Loutre course. However, the channel should have retained significant flow, especially during high water seasons. This flow would have allowed Magnolia Crevasse to remain open and provide a link between the site and both the modern La Loutre Channel to the south and the swamp and marsh to the north.

Because of the great size of the site, only Mound B, a conical earthen structure, was selected for the present study. This mound is apparently structurally similar to other known earthen mounds in the region and may be considered typical of mounds on major levee systems. Other features of the site can be seen on the larger site map.

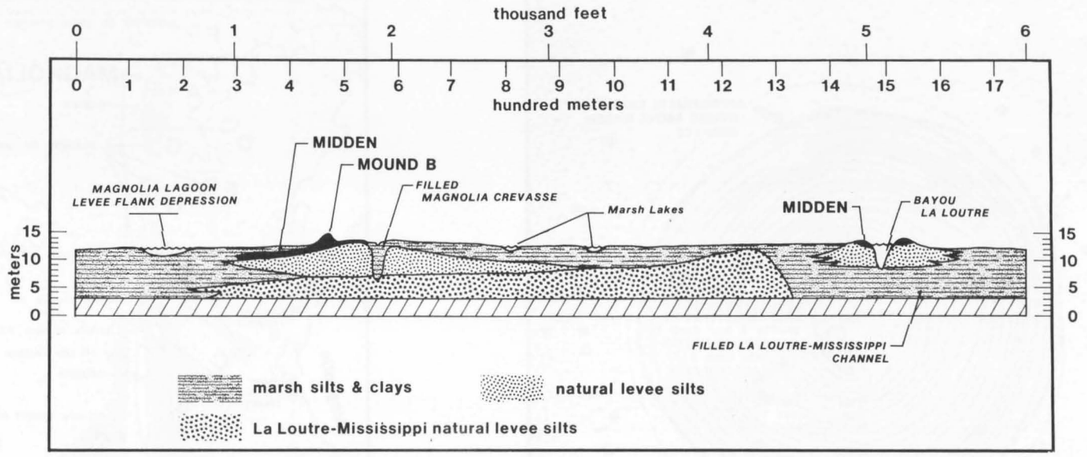


Figure 2-5. *Cross section through the Magnolia Mound site (16 SB 49). Both the La Loutre-Mississippi and Magnolia Crevasse natural levees are indicated. Location of section shown in Figure 2-4.*

Figure 2-6. *Mound B at the Magnolia Mound site (16 SB 49). Note the heavy vegetation cover in the otherwise flat expanse of marsh. Mound C can also be seen in the right background. View to the south-southwest. Date: 7/13/79.*

Figure 2-7. *Mounds projecting above the marsh at the subsided Magnolia Mound site (16 SB 49). View to the north. Date: 7/13/79.*

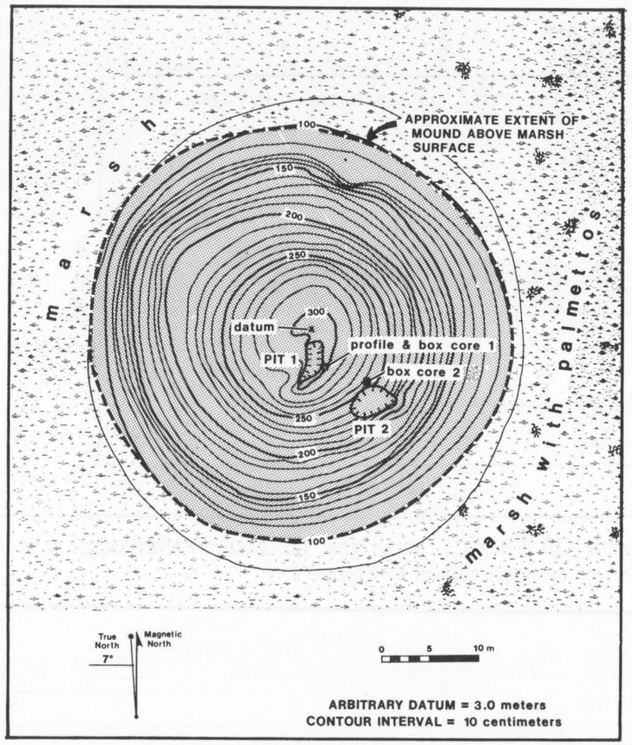


Figure 2-8. *Coutour map of Mound B at the Magnolia Mound site (16 SB 49). The mound is an excellent example of a conical structure.*

Although large, the site appears to have an uncomplicated history. Initial occupation occurred during the Marksville period (circa A.D. 1-400), and unless submerged remains provide new data, it was late in that period. The conical mounds at the site, including Mound B, were probably constructed during the Marksville occupation. Following a long hiatus, the site was reoccupied by Plaquemine peoples. It was during this period (circa A.D. 1000-1400) that the pyramidal mounds were constructed, the most notable of which is the large "Magnolia Mound" (Mound A).

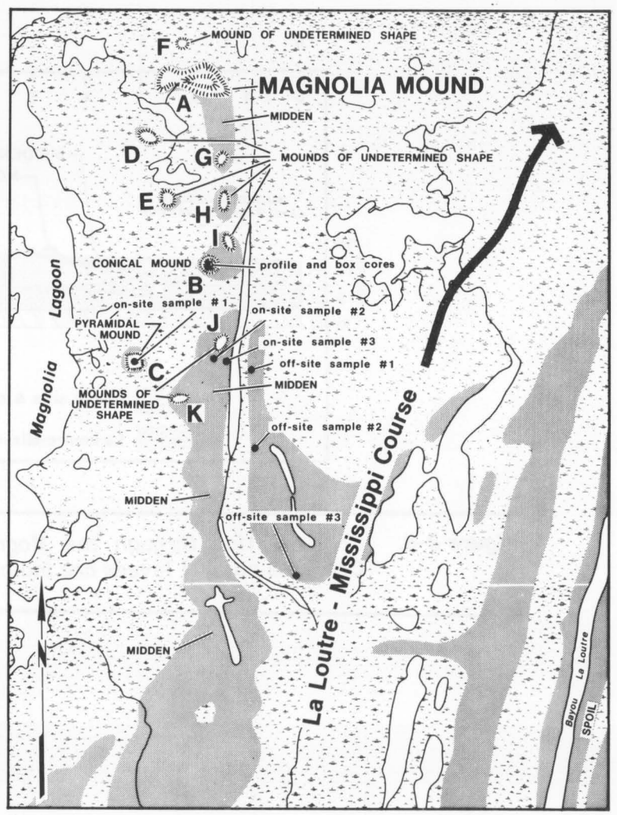


Figure 2-9. *Generalized map of the Magnolia Mound site (16 SB 49) illustrating the mounds and middens along the crevasse natural levee. Mound B was examined in the present study (modified from Gagliano, Weinstein, and Burden 1978:Fig. 21).*

References:

U.S. Geological Survey 1893; Kniffen 1936; McIntire 1958; Phillips 1970; Neuman 1977; Gagliano, Weinstein, and Burden 1978; Wiseman, Weinstein, and McCloskey 1979.

minor natural levee

Much like sites associated with major natural levees, this category reflects the selection on the part of prehistoric populations of high, well-drained ground for settlement. In an otherwise flat coastal zone, these levees provided one of the few "dry foot" environments on which to conduct most daily activities. As with major levees, sites on minor levees can be expected along the levee crest, at the junction of the stream and a crevasse distributary, or at the distal ends of the levee. In coastal Louisiana, many of the minor natural levees are associated with small crevasse distributaries. Although small, these levees and their respective high probability areas could still be identified by sub-bottom profiles, especially if the crevasse channel could be traced back to its parent stream.

For the present study, two sites located on small natural levees have been chosen. These are Shotgun Shell (16 SB 52) and the Lower Vacherie Mound (Shellhill Plantation) (16 SJ 2), both located in southeast Louisiana.

SHOTGUN SHELL (16 SB 52)

The Shotgun Shell site is a relatively small Rangia shell midden situated atop the subsided natural levee of the Magnolia Crevasse channel (discussed previously). At the site location, the crevasse had dwindled in size and appears on infrared aerial photographs as a narrow, sinuous band of brown in an otherwise unbroken expanse of reddish-hued marsh.

Examination of the area map (Figure 2-4) demonstrated that the crevasse channel upon which the site is located could be identified within a three-mile lease block survey. However, it would be necessary to use the surrounding lease blocks to determine the origin of the stream, in this case the large La Loutre-Mississippi course.

Figure 2-10. *The Shotgun Shell midden (16 SB 52) in the St. Bernard Parish marshes. View to the west. Date: 7/10/79.*

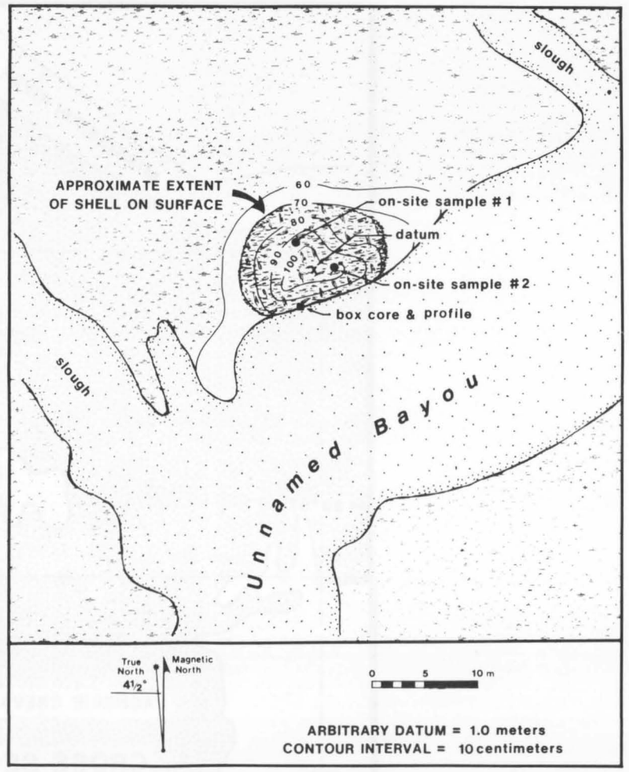


Figure 2-11. *Map of the Shotgun Shell site (16 SB 52) in the marshes of St. Bernard Parish.*

The site itself measures approximately 15x20 m and rises about 0.4 m above the surrounding marsh. The depth of the site has not been determined, though it is probably a meter or less. This assumption is based on the known subsidence depth of other sites along the Magnolia Crevasse. The midden is composed almost exclusively of Rangia shells in a black, humic matrix. One burial was noted in the midden in close proximity to the location of the box core. Cultural components of the site are not adequately known at present. Several clay-tempered sherds have been found at the site but none are diagnostic. Based on the site's location along the Magnolia Crevasse, though, a possible initial occupation during the late Marksville period is suggested. This would coincide with the earliest known occupation at the Magnolia Mound site. A few shell-tempered ceramics have been recovered from the Shotgun Shell site indicating a (minor?) Mississippi period occupation.

References:

McIntire 1958; Phillips 1970; Neuman 1977; Gagliano, Weinstein, and Burden 1978; Wiseman, Weinstein, and McCloskey 1979.

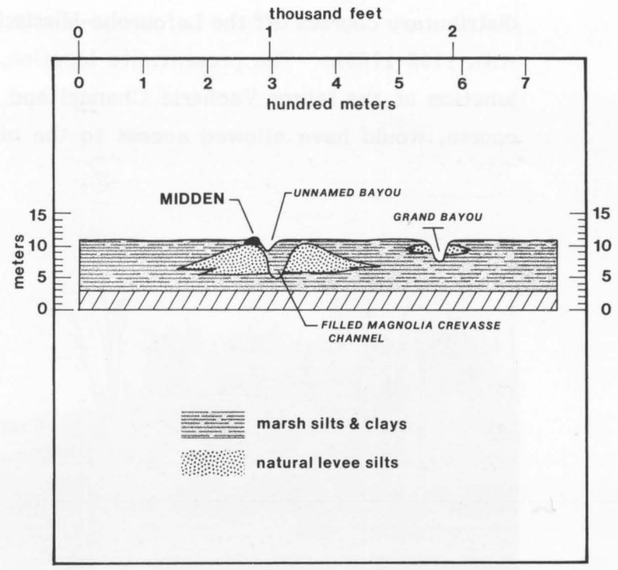


Figure 2-12. *Cross section through the Shotgun Shell site (16 SB 52). Note the submerged natural levee upon which the site rests. Location of section shown in Figure 2-4.*

LOWER VACHERIE MOUND (SHELLHILL PLANTATION) (16 SJ 2)

The Lower Vacherie Mound (also known as the Shellhill Plantation site) is located on the subsided natural levee of a minor crevasse off the larger Vacherie Crevasse, the latter emanating from a course within the Modern Mississippi River meander belt (circa 2700 B.C. to present). Subsequent Vacherie Crevasse sediments have partially obscured the depositional sequence, but individual channels still can be seen on aerial photographs and soil survey maps. To the southwest and south of the Vacherie Crevasse channel are distributary courses off the Lafourche-Mississippi (circa A.D. 1100-1700). The present site location, near the junction of the larger Vacherie Channel and a smaller course, would have allowed access to the biologically

Figure 2-13. *Mound at the Lower Vacherie site.*

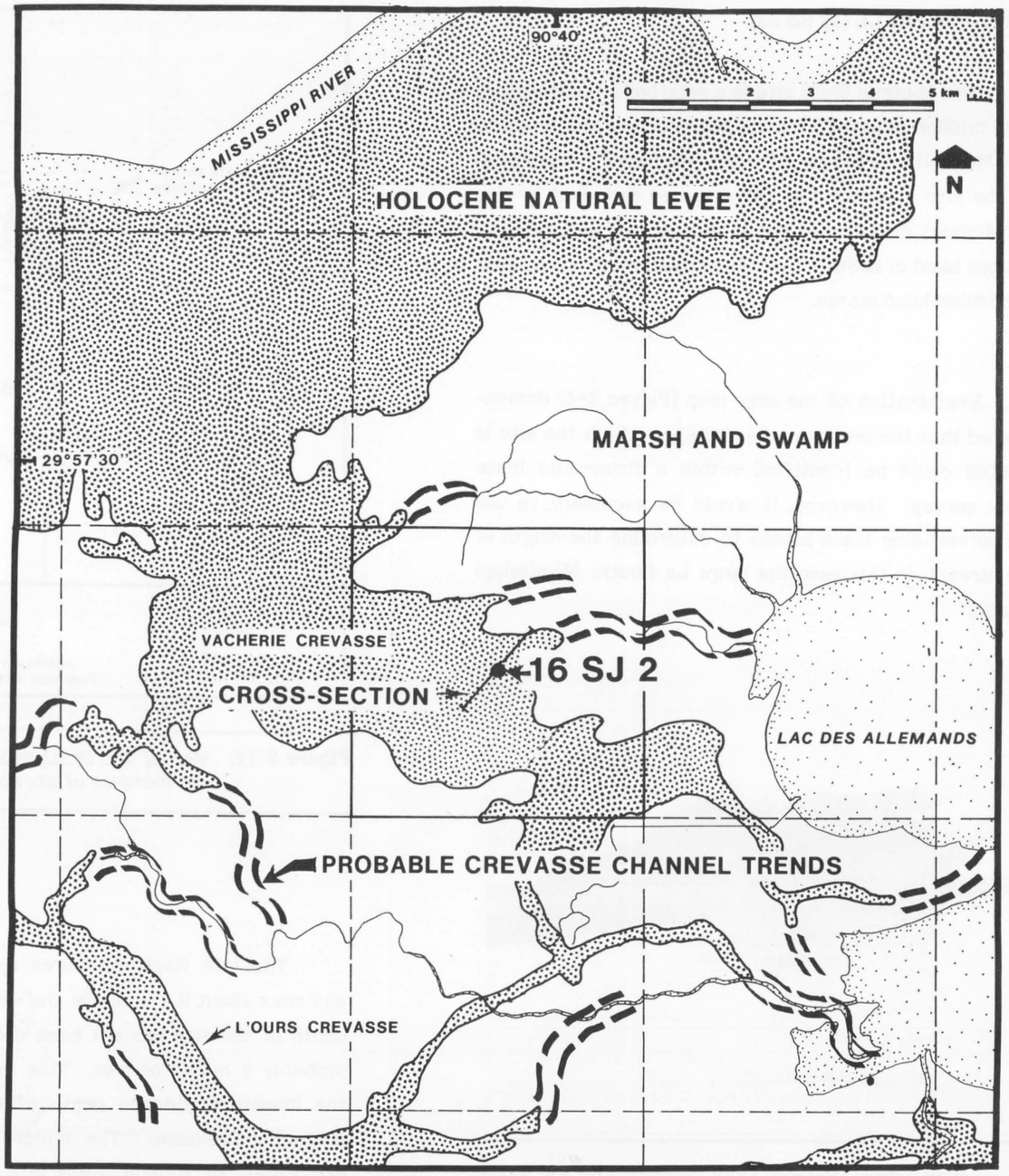


Figure 2-14. *The Lower Vacherie Mound (16 SJ 2) situated on the natural levee soils of the Vacherie Crevasse.*

rich swamps and marshes to the east as well as to the Mississippi River. If this site were submerged, and one were to examine the data from a three-mile lease block centered on the site, only the Vacherie Crevasse and its associated distributaries would be noticeable. Sub-bottom profiles would, however, indicate the small crevasse upon which the site is located, and would also probably allow one to identify the course of the crevasse.

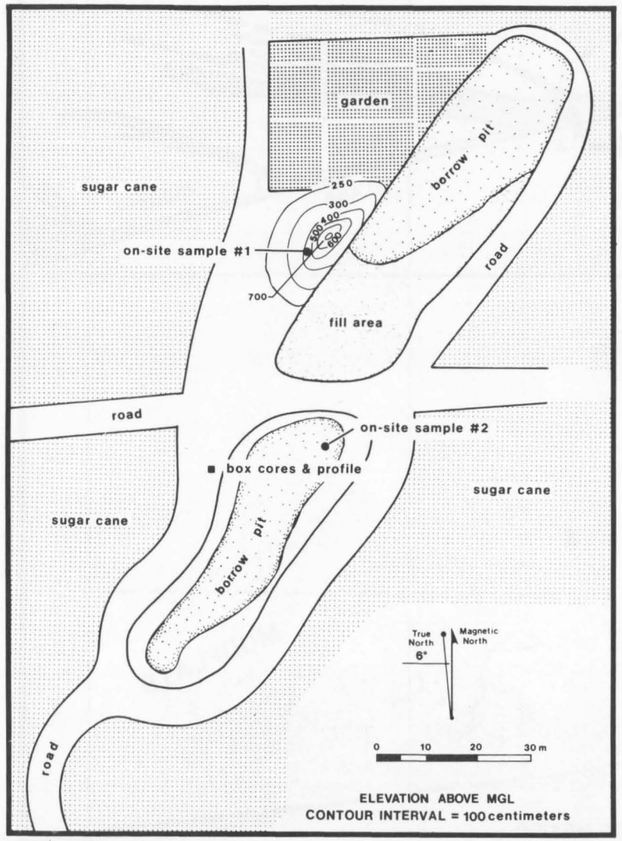


Figure 2-15. *Map of the Lower Vacherie Mound (16 SJ 2) illustrating the damage caused by past shell dredging operations (courtesy of Brian Duhe and Dan Shipman).*

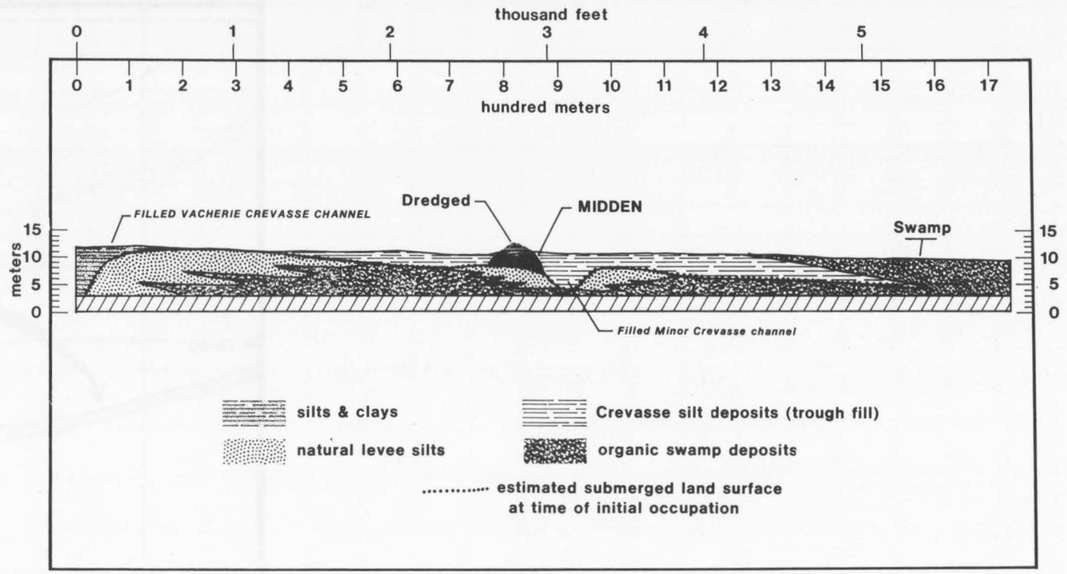


Figure 2-16. *Cross section through the Lower Vacherie Mound (16 SJ 2). Note that the site has been covered by silts off the Vacherie Crevasse. Location of cross section shown in Figure 2-13.*

The site is a relatively large accumulation of shell, earth, and faunal layers compiled into a rich midden covering an area approximately 150 m long by 70 m wide. A small Rangia shell and earthen mound is located at the site and now stands about 2 m high. The site was badly degraded by commercial shell dredging activity in the late 1940s. Despite this, however, large fringing portions still retain stratigraphic integrity. Recent excavations conducted by the Delta Chapter of the Louisiana Archaeological Society, led by Brian Duhe of Reserve, Louisiana, have provided a wealth of valuable data on the site. Test pits into the surrounding midden area have been excavated to a depth of 3 m. The midden, however, is deeper. In Test Pit 1, the sequence of deposits is as follows: 0-26 cm, Rangia shell midden; 26-38 cm, overbank flood deposits of silty clay; 38-76 cm, Unio shell midden; 76-100 cm, loose bone (mostly fish) in matrix of black earth midden; 100-170+ cm, compact bone layer (again almost entirely fish). Burials have been noted in the upper Rangia level, while excellent floral preservation is known from the lower levels. Perishable artifacts, such as twined cordage and wooden implements, have been uncovered in the lower midden zones. Cultural components present are tentatively identified as follows: Marksville, Baytown, Coles Creek, Plaquemine, possible Mississippian, and Historic contact. There is also the potential for a deeply buried Tchefuncte component.

References:

Duhe, personal communication, 1979.

chenier and accretion ridges

Two of the most visually prominent and ideally suited landforms for prehistoric habitation are the chenier (beach) and accretion ridges of southwest Louisiana and southeast Texas. Formed by the natural accumulation of reworked marine shells and sand, these long, narrow ridges mark the former locations of ancient Gulf shorelines or the mouths of relict and modern rivers and bayous.

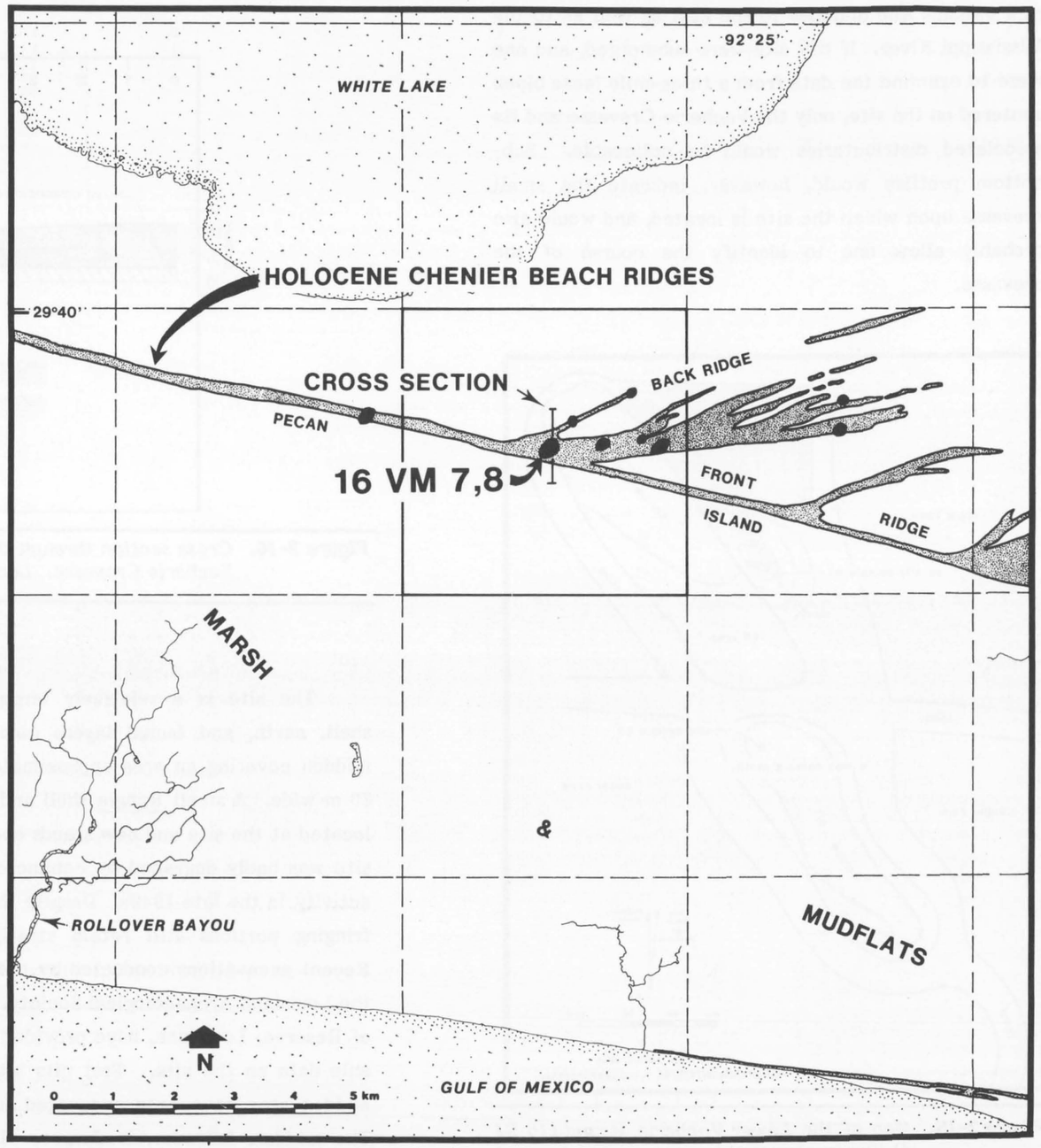


Figure 2-17. *The Pecan Island chenier in the marshes of south-central Louisiana. The locations of Veazey (16 VM 7 and 8) and other nearby sites are indicated.*

Most sites on these ridges can be found at recognizable locations. These include: 1) areas where ancient or modern bayous brush the sides of a ridge; 2) areas where two or more ridges are joined; 3) areas at the edges of a ridge where it fronts on a lake or bay. Submerged ridges on the OCS can be identified by present instrumentation, such as bathymetry and subbottom profiles.

Four sites, Veazey (16 VM 7 and 8), Pierre Clement (16 CM 47), Jeff Simmons (16 CM 84), and Smith Ridge (16 CM 49), were selected as the terrestrial analogs to submerged potential sites associated with cheniers or accretion ridges.

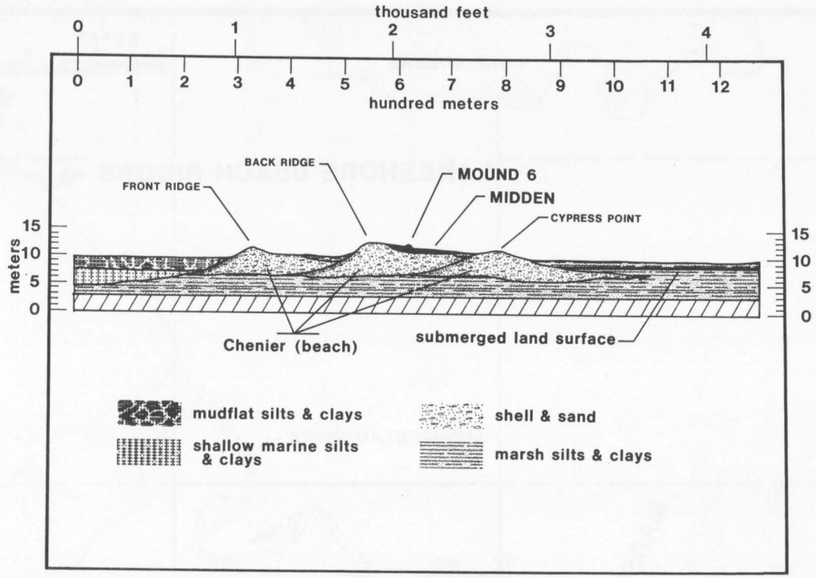


Figure 2-19. *Cross section through the Pecan Island chenier at the Veazey site (16 VM 7 and 8). Location of section shown in Figure 2-17.*

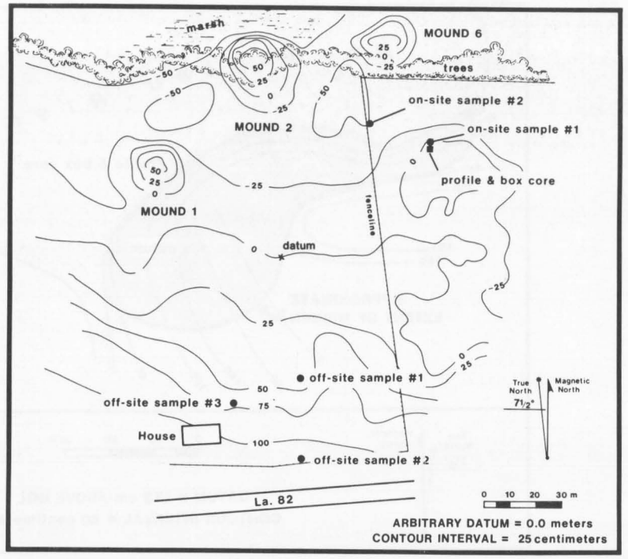


Figure 2-18. *The Veazey site (16 VM 7 and 8) showing the three remaining mounds and areas sampled during the present study (courtesy of Ian W. Brown).*

VEAZEY (16 VM 7 and 8)

Located on Pecan Island, a chenier just south of Grand Lake, south-central Louisiana, the Veazey site is situated at the junction of Front, Back, and Cypress Ridges. The site at one time consisted of 11 mounds spread over an area measuring approximately 175 m long and 75 m wide. The highest mound today stands 1.5 m above the chenier, but other mounds were undoubtedly higher. Recent (1979) excavation by Ian Brown of the Peabody Museum, Harvard University, has revealed that the midden deposits at the site are between 50 and 60 cm deep and consist of stratified earth lenses intermixed with combined sparse shell and earth lenses. The entire deposit rests directly atop the chenier beach matrix of Pecan Island. In an earlier excavation at the site, Collins, in 1926, found that some of the mounds were not stratified but were probably constructed as single-stage burial structures.

The site's cultural components reveal five segments of occupation of unequal intensity. A scanty Tchefuncte component (circa 500-1 B.C.) is followed by a strong Marksville period occupation (circa A.D. 1-400) which was probably responsible for the burial mounds, followed by a weak Baytown interval (circa A.D. 400-700), and lastly by two strong components of the Coles Creek (circa A.D. 700-1000) and Plaquemine cultures (circa A.D. 1000-1400).

References:

Collins 1927, 1941; McIntire 1958; Phillips 1970; Neuman 1977; Brown, Fuller, and Lambert-Brown 1979.

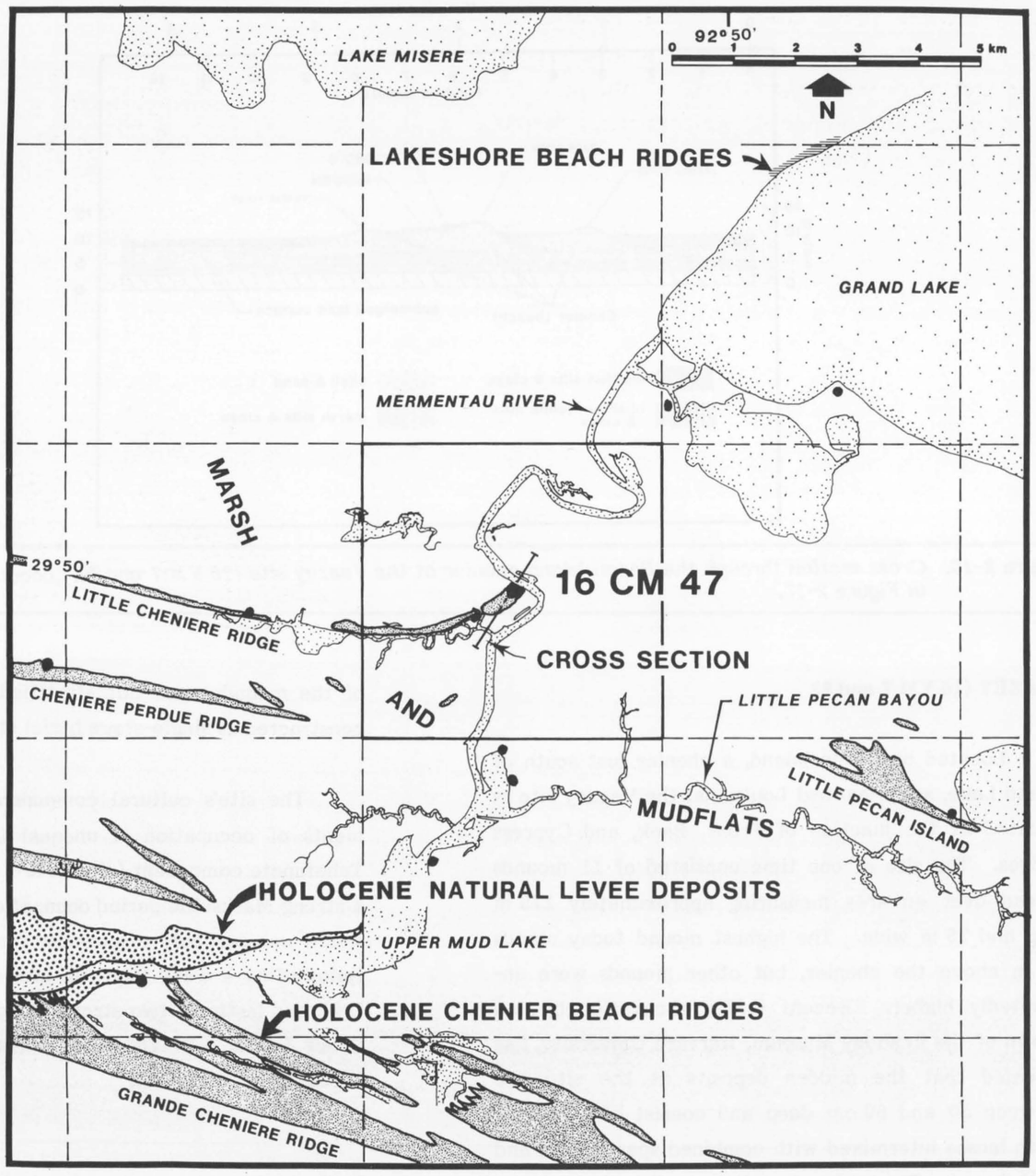


Figure 2-20. *General location of the Pierre Clement site (16 CM 47) at the eastern tip of Little Cheniere Ridge.*

PIERRE CLEMENT (16 CM 47)

The Pierre Clement site is situated at the extreme eastern end of Little Chenier, adjacent to the modern channel of the Mermentau River, in southwestern Louisiana. The environment of the area at the time of initial site occupation was probably not much different than that of today, although the Gulf of Mexico may have been closer to the site.

Today the Pierre Clement site covers an area of approximately 1056 sq m, measuring about 50 m long by 30 m wide. Excavations in the early 1970s by James Springer, then of Yale University, examined an area of 7.4 sq m and found that the site consisted of a Rangia

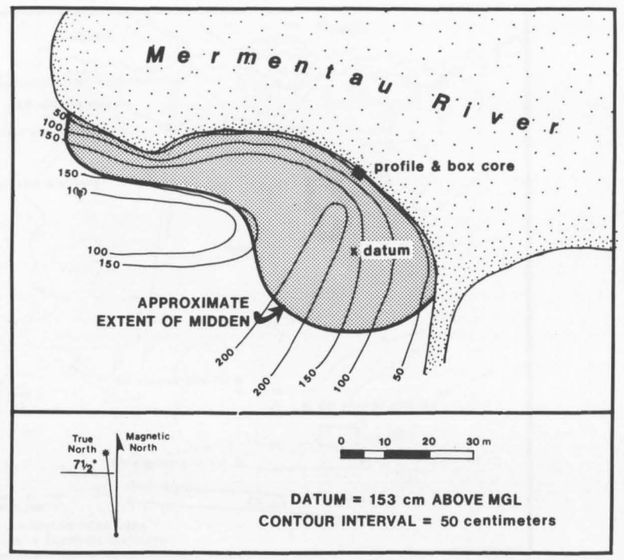


Figure 2-21. *The approximate extent of the midden deposits at the Pierre Clement site (16 CM 47) (modified from Springer 1973:Fig. 22).*

Figure 2-22. *Cleared profile along the bank of the Mermentau River at the Pierre Clement site (16 CM 47). Note the levels of shell and midden. View to the south-southwest. Date 9/4/79.*

shell midden overlying a Rangia and earth midden, this superimposed over an oyster shell layer which, in turn, rested atop the chenier beach matrix. The last two layers were not considered cultural deposits. Burials were retrieved from the upper Rangia lens.

The site contains the remains of probably three cultural groups. The earliest is Coles Creek which is followed by a Plaquemine component and a tentative Mississippian-like component (circa A.D. 1400-1700), the latter based on shell-tempered sherds. It may be possible to refer to this component as a protohistoric Attakapa occupation.

References:

McIntire 1958; Springer 1973, 1979; Neuman 1977; Weinstein, Burden, and Frank 1977; Burden et al. 1978.

Figure 2-24. *Bankline at the Pierre Clement site.*

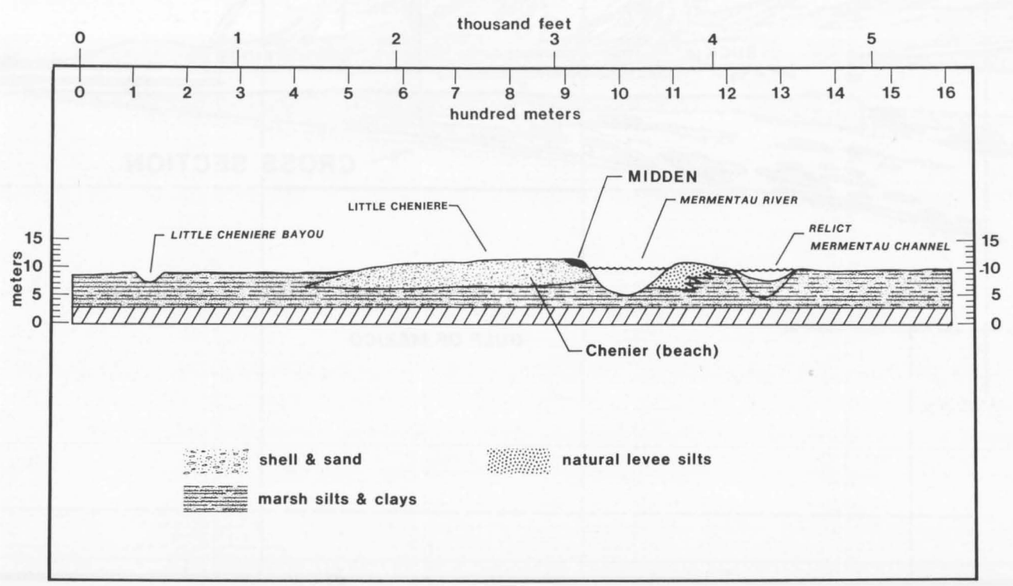


Figure 2-23. *Cross section through Little Cheniere at the Pierre Clement site (16 CM 47). Location of section shown in Figure 2-20.*

JEFF SIMMMONS (16 CM 84)

A long and relatively pronounced series of accretion ridges can be found for several kilometers east and west of the mouth of the Sabine River. These fan-shaped features are composed of the same reworked marine shells and sand as chenier beach ridges. The processes forming the two features are similar as well, both being subject to a longshore deposition and shoreline progradation. However, where mouths of rivers either now or previously emptied into the Gulf, the ridges develop splayed patterns reflecting the combined effects of Gulf and riverine currents. The Jeff Simmons site is located along the back slope of Blue Buck Ridge, an accretion ridge in Cameron Parish, Louisiana.

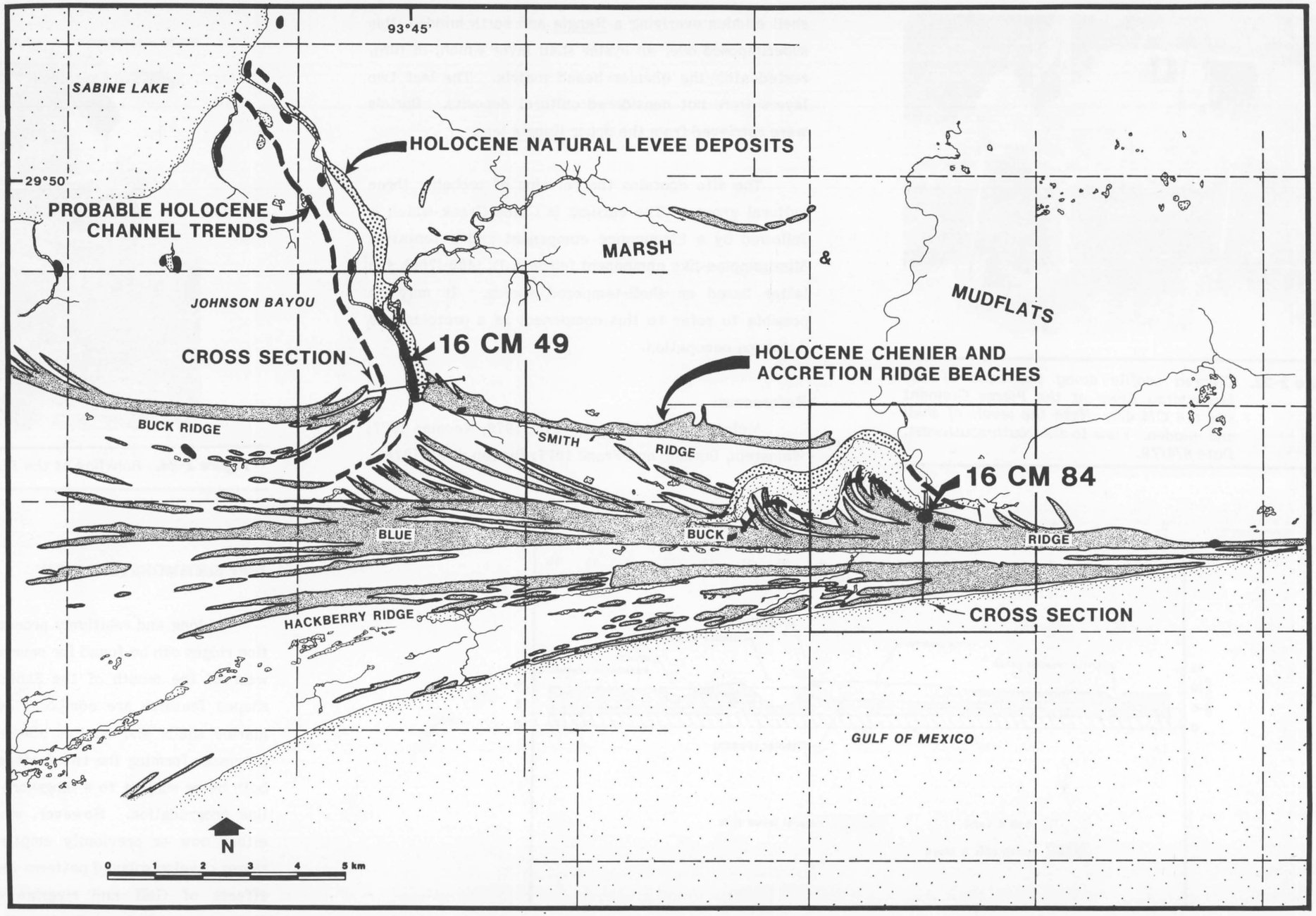


Figure 2-25. *The Blue Buck and Smith ridges of southwestern Louisiana, showing the locations of the Jeff Simmons (16 CM 84) and Smith Ridge (16 CM 49) sites. Note also the possible courses of the Sabine River.*

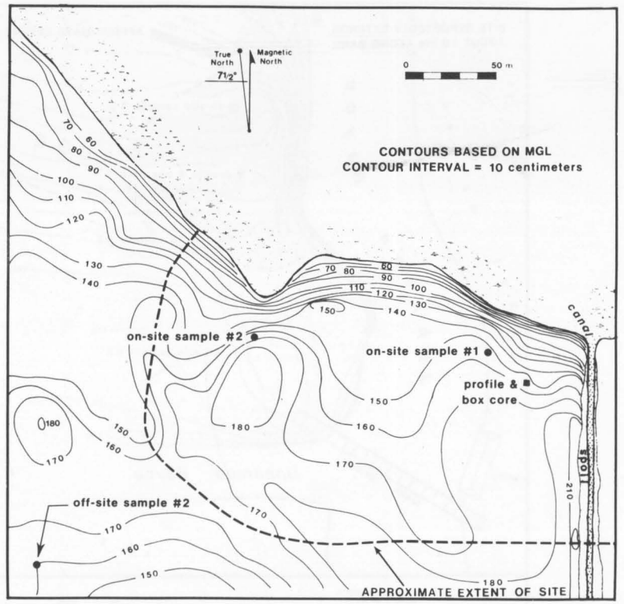


Figure 2-26. *The western portion of the Jeff Simmons site (16 CM 84) at the edge of Blue Buck Ridge (modified from Stopp 1976:Fig. 3).*

The present geological history of the site area is difficult to interpret. Hamilton Lake, which abuts against the north side of Blue Buck Ridge, and which was undoubtedly one of the prime reasons for prehistoric occupation at the Jeff Simmons site, is an enigma at present. The lake appears to represent the remains of an ancient river channel, but when and by what river this channel was formed is not known. Different theories attribute the channel to either a relict, Pleistocene-age Mississippi River scar, an abandoned course of the Calcasieu, or a similar remnant of the Sabine. The present study has chosen to follow the latter theory simply because of the proximity of the Sabine and since another relict channel, now occupied by Johnson Bayou (to be discussed below), appears to also represent an old Sabine course. Whatever the case, a situation such as this (a site on the edge of an accretion ridge next to a now-filled channel of a relatively large river) should certainly be considered as a high probability locale if found on the OCS.

The Jeff Simmons site itself is rather extensive, running along the margin of Hamilton Lake for several hundred meters. That portion west of the canal shown in the site map has received the most in-depth study, in the form of test excavations, controlled surface collections, and mitigation excavation. This segment of the site measures 250 m long by 100 m wide, and has a midden depth of about 35 cm.

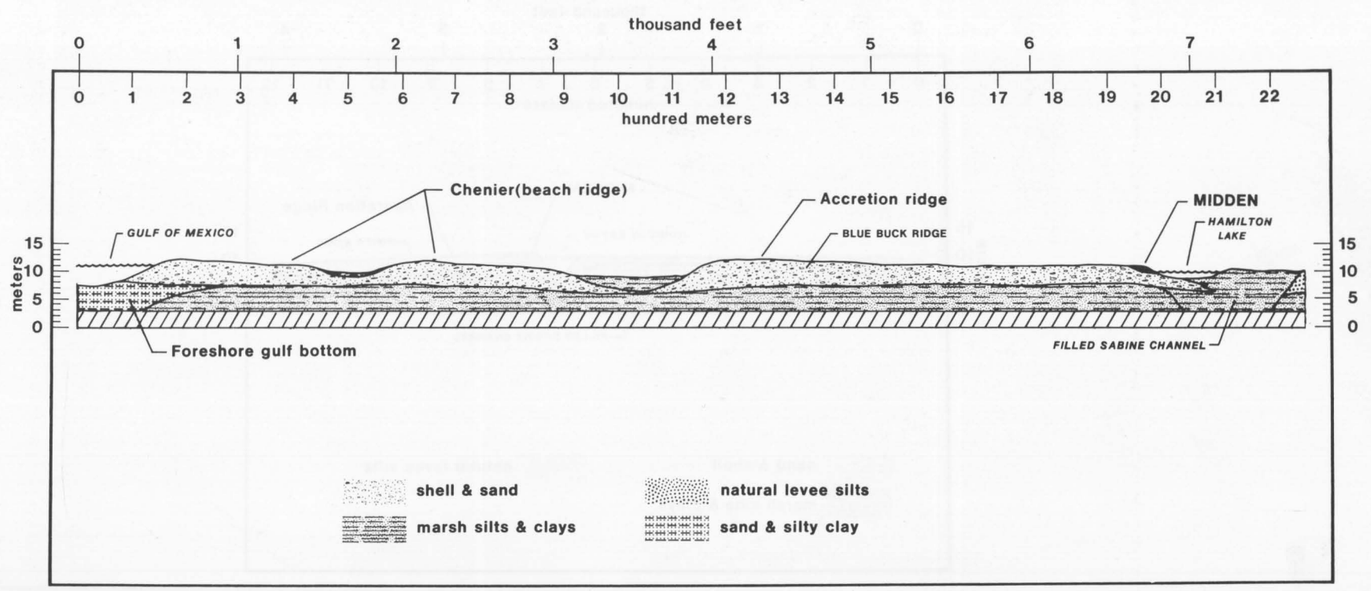


Figure 2-27. *Cross section through the Jeff Simmons (16 CM 84) site and the Blue Buck accretion ridge upon which the site is situated. Location of section shown in Figure 2-26.*

The excavations, conducted in 1975 by G. Harry Stopp, Jr., then of McNeese State University, revealed a midden composed of black earth with a high sand content. Various trash pits were also noted extending below the midden zone into the underlying marine shell matrix. Cultural components were difficult to identify, but the basic occupation appears to have been late Coles Creek and Plaquemine cultures. This was followed by scant utilization of the site by what were probably protohistoric Attakapa groups.

References:

Stopp 1976; Wiseman et al. 1979; Weinstein et al. 1979.

SMITH RIDGE (16 CM 49)

Smith Ridge is the second site associated with an accretion ridge in Cameron Parish, Louisiana. It is situated at the western end of Smith Ridge along the east bank of Johnson Bayou. As mentioned above, Johnson Bayou may represent an underfit stream which has reoccupied a possible Sabine River channel. Natural levee deposits presently exposed along the eastern side of this old channel indicate that the stream forming the channel was of substantial size. After the channel was abandoned, the ridges developing to the south of the area obscured the actual course. Again, the location of the site in respect to ridge and river position would be considered a high probability area for site occurrence, and could be identified with present technology on the OCS. In fact, a look at the area map, presented earlier, shows that one three-mile lease block would provide sufficient information for determining the specific landforms around the site.

As a site, Smith Ridge is long and sinuous, following the edge of Johnson Bayou for much of its length. The southern end, however, shown on the site map, is situated atop natural levee deposits of the old Sabine course which, in turn, overlie the marine shell matrix of the accretion ridge. The site measures 30 m wide near the southern end, but extends about 1.4 km up the bayou. An eroded Rangia shell midden occupies much of the site along the bayou edge, but a small, in

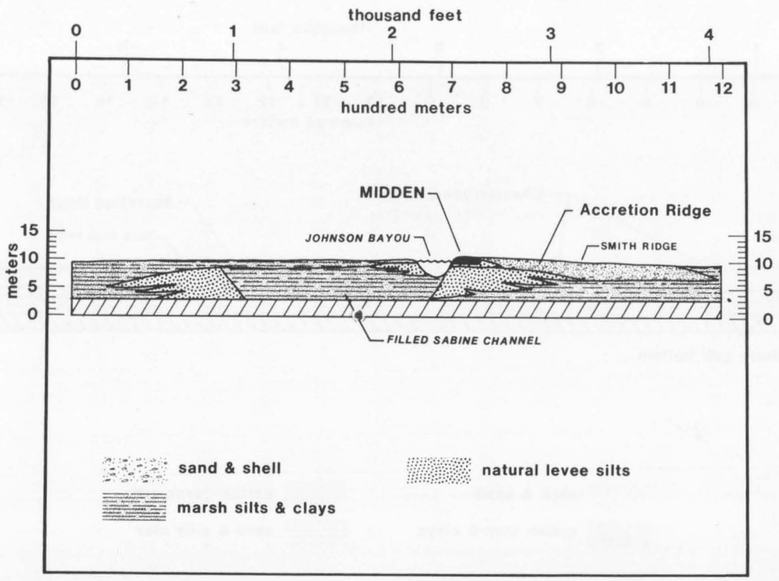


Figure 2-28. *Cross section through Smith Ridge at the Smith Ridge site (16 CM 49). Note that the site is resting atop natural levee soils of Johnson Bayou and the earlier Sabine River course. These soils, in turn, have been partially masked by accretion ridge deposits. Location of section shown in Figure 2-26.*

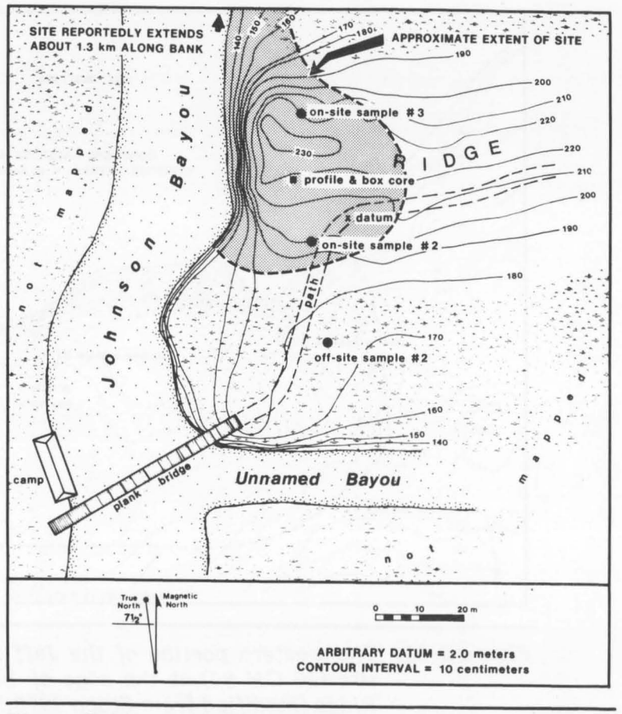


Figure 2-29. *Southern portion of the Smith Ridge site (16 CM 49) where the accretion ridge joins Johnson Bayou.*

situ, black earth midden exists on the natural levee deposits on Smith Ridge. This midden extends to an average depth of 25 cm.

Although no systematic excavatons have ever occurred at the site, several surface collections provide evidence of Plaquemine and protohistoric Attakapa cultures. A locale situated nearby on Smith Ridge, the Billot site (16 CM 109), reportedly contained numerous burials and may represent a cemetery utilized by the Indians living at the Smith Ridge site.

References:

McIntire 1958; Haag 1971.

barrier island

Another landform likely to have been used extensively by prehistoric inhabitants and which can be identified on the OCS through bathymetry and subbottom profiles is the barrier island or barrier-spit complex. These features develop in two ways. In the first, during periods of relative still stand, inlet migration in a downdrift direction may cause the growth of beach deposits (Coastal Environments, Inc. 1977: 181-185). When this occurs, the time interval during which the landform was available for occupation may range from a few hundred to several thousand years.

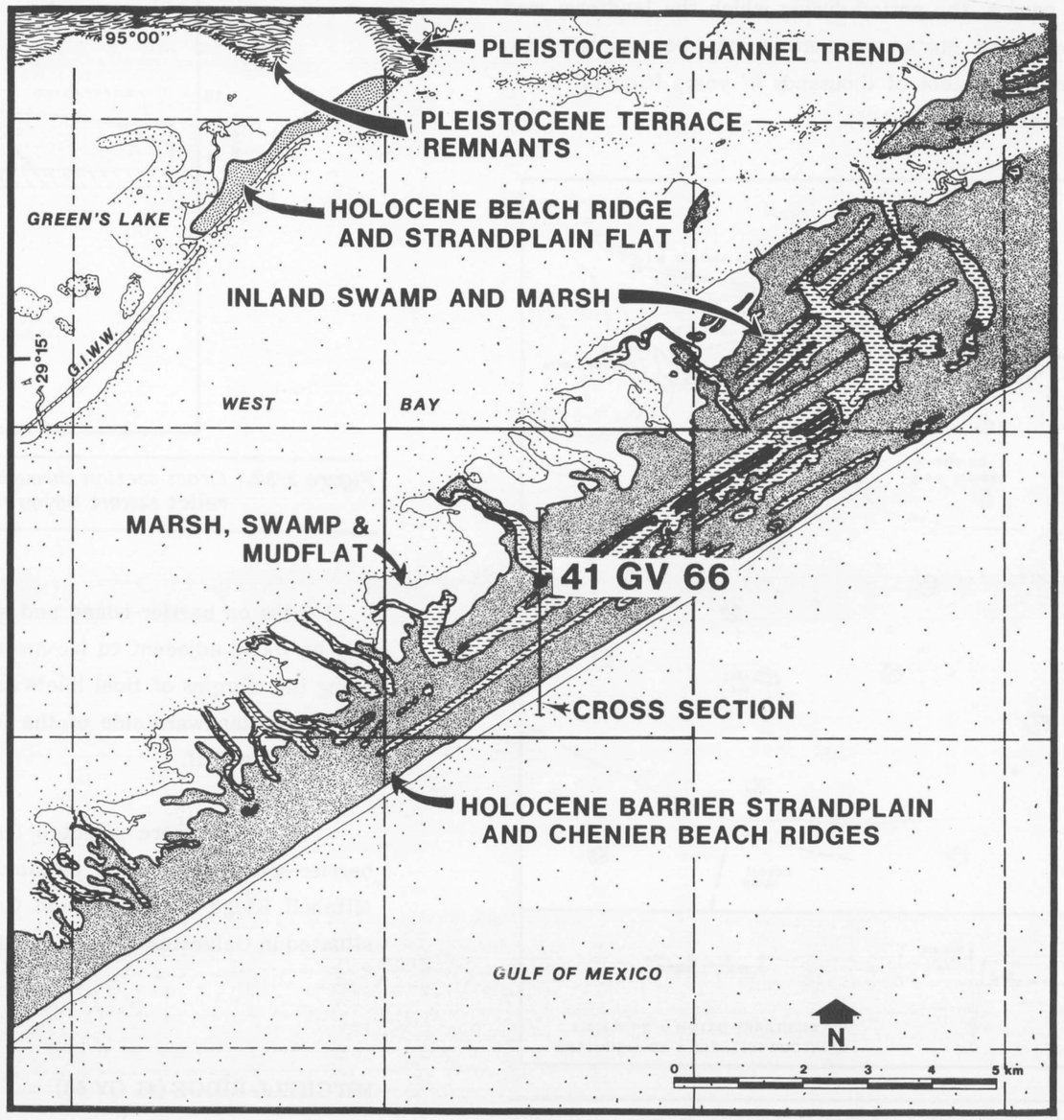


Figure 2-30. *Galveston Island, a barrier island on which the Mitchell Ridge site (41 GV 66) is located.*

In the second manner, a reestablishment of the same shoreline, after an interval of sea level fall and rise, may cause a barrier-spit complex to form. When this occurs, the period during which the landform was suitable for human occupation may be separated by thousands or tens of thousands of years (Coastal Environments, Inc. 1977:185).

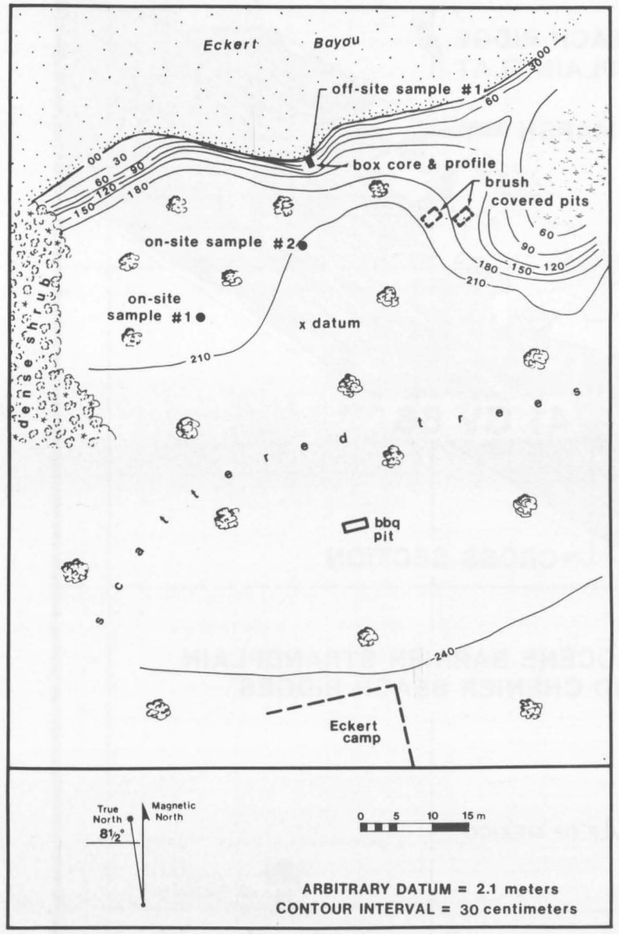


Figure 2-31. *A portion of the Mitchell Ridge site (41 GV 66) at which soil and geochemical samples were obtained.*

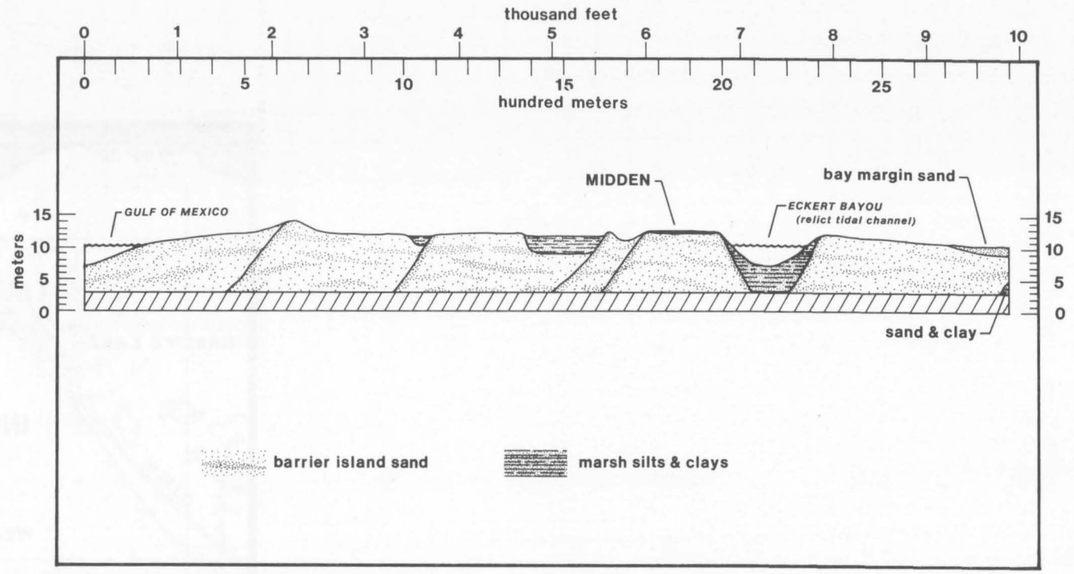


Figure 2-32. *Cross section through Galveston Island at the Mitchell Ridge site (41 GV 66). Note the site's proximity to the relict Eckert Bayou tidal channel. Location of section shown in Figure 2-30.*

Sites on barrier-island and spit features can usually be found adjacent to freshwater lakes or ponds or along the margins of tidal inlets and passes. Most sites are on the landward side of the feature, closer to the bay than the Gulf.

Two sites were selected from those located on barrier-spit complexes for detailed analysis. These are Mitchell Ridge (41 GV 66) and Caplen (41 GV 1), both situated in Galveston County, southeastern Texas.

MITCHELL RIDGE (41 GV 66)

Mitchell Ridge is situated along the western edge of Eckert Bayou, a relict tidal pass, on the central and highest ridge which runs in a northeast-southwest direction on Galveston Island, a Holocene-age barrier island. It is believed that when the site was initially occupied, during the Late Archaic peirod, the pass was an active water body connecting West Bay with the Gulf of Mexico. During the major occupation at the site, however, which is believed to have been by prehistoric Karankawa, the pass was simply a means of access to the marshes and mudflats fringing the bay margin of the island, and to West Bay and the Texas mainland. As such, the site was located in one of the most economically suitable and attractive locales on the island.

The site itself consists of scattered midden deposits covering most of the ridge top. A major concentration, measuring about 300x300 m and averaging 30 cm in depth, is situated adjacent to the bayou. It

consists of a rich earth midden with scattered occurrences of oyster shell. Hearths and burials have been found during recent (1975-1978) excavations conducted by the Texas Archaeological Society, under the direction of Barbara Bruce Atkins.

References:

Atkins, personal communication, 1980.

Figure 2-33. *View to the east along the eroded beach edge at the Mitchell Ridge site (41 GV 66). Date: 10/18/79.*

CAPLEN (41 GV 1)

The Caplen site is a well-known cemetery situated on a small knoll on the bay side of Bolivar Peninsula, Galveston County, Texas. This peninsula is part of the same barrier-spit complex discussed above for the Mitchell Ridge site, and as such would have provided occupants of the spit an environmental setting similar to that found at Mitchell Ridge.

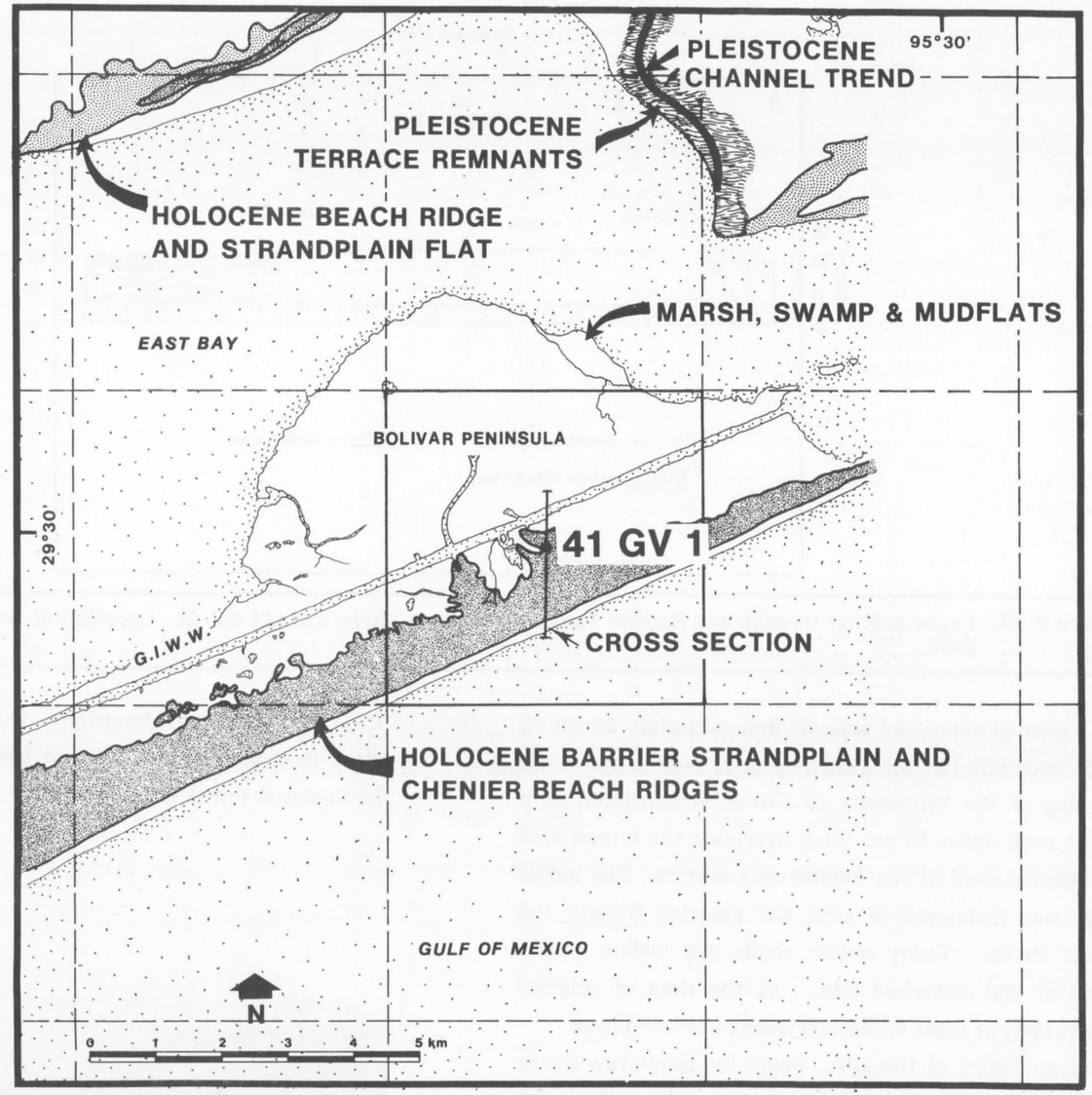


Figure 2-34. *Bolivar Peninsula of southeast Texas showing the location of the Caplen site (41 GV 1).*

Caplen, however, is not a true habitation locale, but a cemetery, so its environmental setting cannot be equated to an area necessary for day-to-day living. No active or relict stream channels are adjacent to the site, nor is it on the highest location on the peninsula. The nearest water is found in the brackish marsh around the site and within several open marsh ponds. It is, nevertheless, typical of a class of sites which is known to be associated with barrier-spit complexes and chenier beach ridges, and which may occur on the OCS.

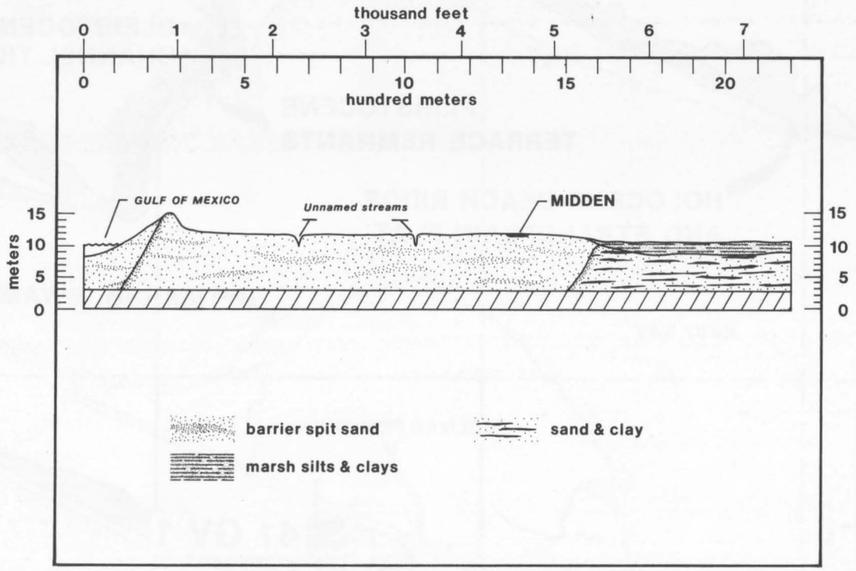


Figure 2-35. *Cross section through the Bolivar Peninsula at the Caplen site (41 GV 1). Location of section shown in Figure 2-34.*

Caplen covers an area of approximately 50x50 m. When excavated in the 1930s, by J. E. Pearce and A. M. Woosley of the University of Texas, it consisted of a burial zone about 50 cm thick overlying the mixed sand and marine shell of the barrier-spit matrix. The burial layer was composed of sand and assorted Rangia and oyster shells. Today oyster shells are visible across much of the disturbed site. At the time of original excavation, at least 66 burials were recovered from about one-third of the site. Since the other two-thirds of the site had been previously destroyed by pothunters, it can be estimated that many more burials were present. Grave goods accompanied some of the burials.

The populations responsible for the Caplen cemetery were most likely forerunners of the historic Karankawa or Attakapa. The site has been tentatively assigned to the Round Lake and Old River periods of the Galveston Bay chronology. This is probably equivalent in time to the early and late Mississippi periods farther east (circa A.D. 1000-1700).

Figure 2-36. *The low rise in the marsh on Bolivar Peninsula marking the location of the Caplen site (41 GV 1). View to the southwest. Date: 10/16/79.*

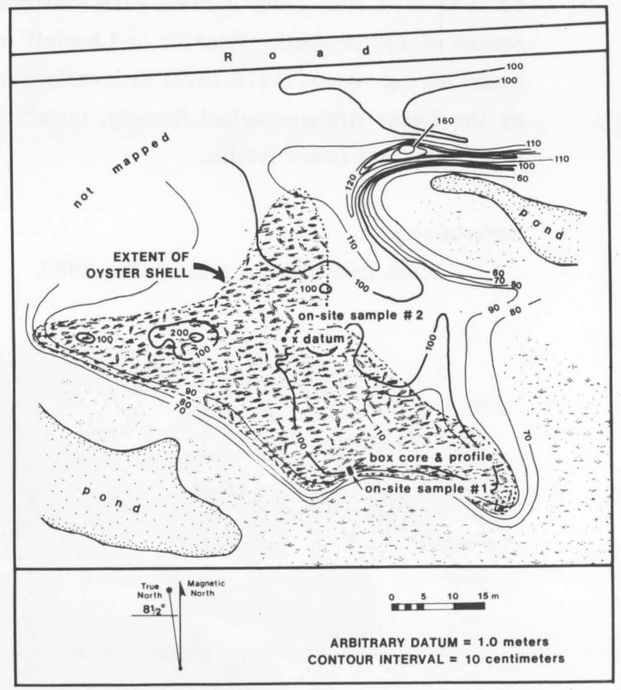


Figure 2-37. *Approximate extent of the oyster deposit marking the location of the Caplen site (41 GV 1).*

Today the site is almost totally destroyed. Pothunters and vandals have badly degraded those areas not excavated by Woosley and Pearce. During the present study, the field party was hard pressed to acquire a sample from an undisturbed portion of the site. What was finally sampled appeared in situ, but it is not above suspicion.

References:

Pearce 1932a,b,c; Sayles 1935; Jackson 1935; Woodbury 1937; Campbell 1957; Aten 1965; Aten et al. 1976.

salt dome margin

For a number of years it has been known that prehistoric sites can be found on or near coastal salt dome islands. In fact, in the low, coastal marshes of southern Louisiana, these uplifted plugs offer particularly attractive places for habitation. This is due, in part, to the raised, stable terrain they provide, and in some instances to the existence of saline springs on their surfaces. Salt dome sites are found around solution ponds or small streams on the island's surface, or adjacent to streams, lakes, or bays around the margin of the dome. Sites associated with the latter features had the added advantage of proximity to the brackish marsh where food resources would have been plentiful, and to the dome itself where high ground would have provided protection in the event of high water. The salt dome locale chosen for examination during the present study was a site of this type. It is the Morton Shell Mound (16 IB 3), also known as the Weeks Island site, located adjacent to the Weeks Island Salt Dome in Iberia Parish, Louisiana.

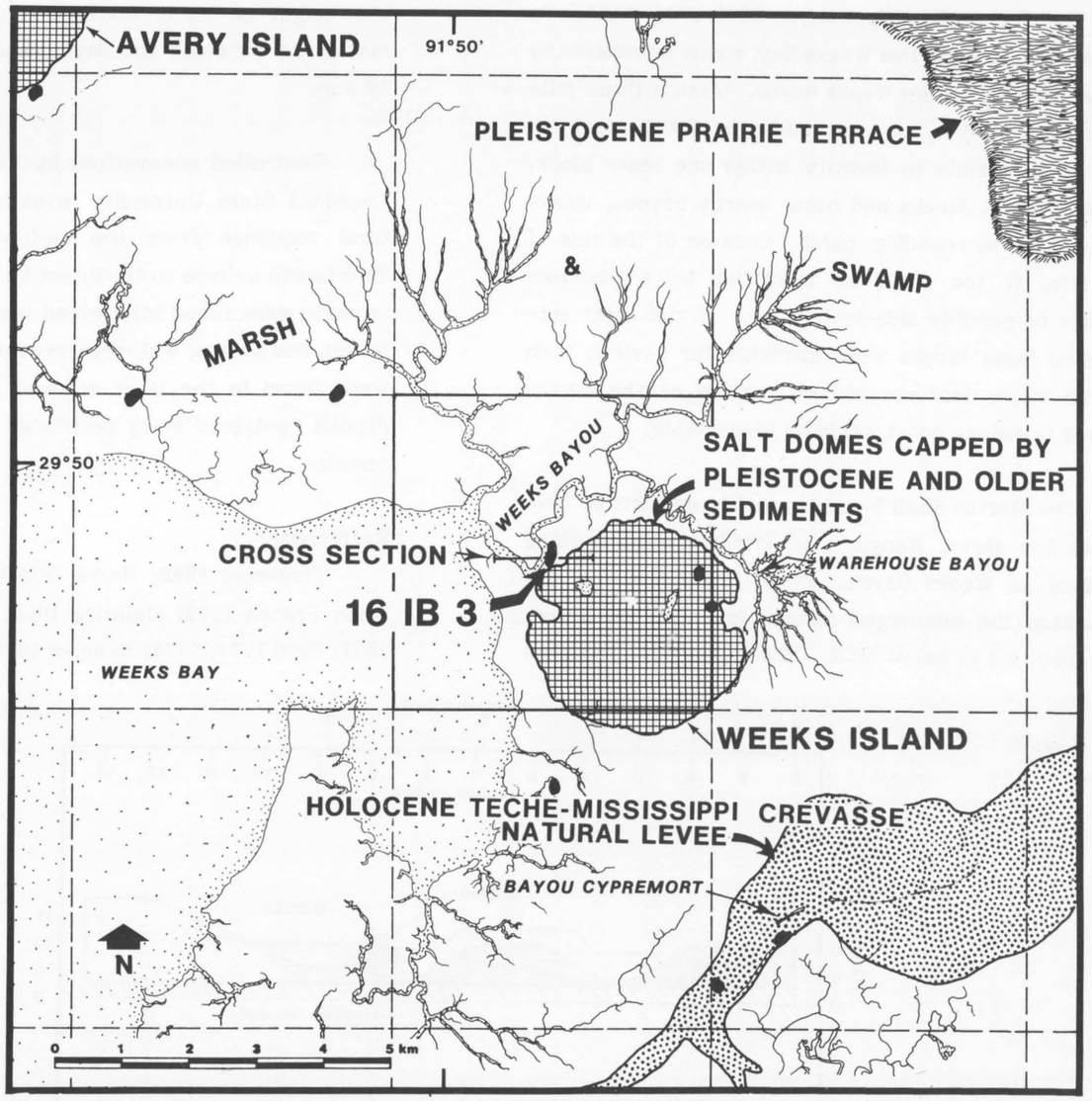


Figure 2-38. *Generalized area map of the Weeks Island Salt Dome. The Morton Shell Mound (16 IB 3) is located adjacent to the dome on Weeks Bayou.*

MORTON SHELL MOUND (16 IB 3)

The Morton Shell Mound is located on Weeks Bayou just northwest of the Weeks Island Dome. The dome itself lies to the southeast of another dome, Avery Island, to the southwest of the nearest exposed Pleistocene Prairie terrace, and to the northwest of the Bayou Cypremort Crevasse channel which emanated

from the Teche-Mississippi (circa 2300-1900 B.C.). To the west of the site lies Weeks Bay, easily accessible by a short boat trip down Weeks Bayou. When a three-mile lease block grid is superimposed over the general region, it is possible to identify within one lease block, the salt dome, Weeks and other nearby bayous, Weeks Bay, and the surrounding marsh. Because of the size of the site, it too could be identified by sub-bottom profiles or possibly side-scan sonar. If the eight surrounding lease blocks were available for review, then all the major features of this portion of the south-central Louisiana coast would be identifiable.

The Morton Shell Mound in reality consists of two, or possibly three, Rangia shell middens aligned along the bank of Weeks Bayou. In all likelihood, the site rests atop the submerged natural levee of the bayou, now about 2.1 m below MGL. The exposed site reaches the height of 3.6 m above MGL, stretches approximately 240 m along the bayou, and attains a width of 30.5 m.

Controlled excavations by Robert W. Neuman of Louisiana State University revealed a continuous cultural sequence from the earliest pottery-producing Tchefuncte culture to the latest Mississippian. Cultural remains were found intermixed with ash layers, Rangia lenses, and a deep, well-preserved peat deposit. Burials were found in the later cultural zones, and the peat deposit contained many perishable artifacts and floral remains.

References:

Thomassy 1860; Harris and Veatch 1899; Veatch 1899; French 1952; McIntire 1958; Phillips 1970; Haag 1971; Byrd 1974, 1976; Neuman 1977.

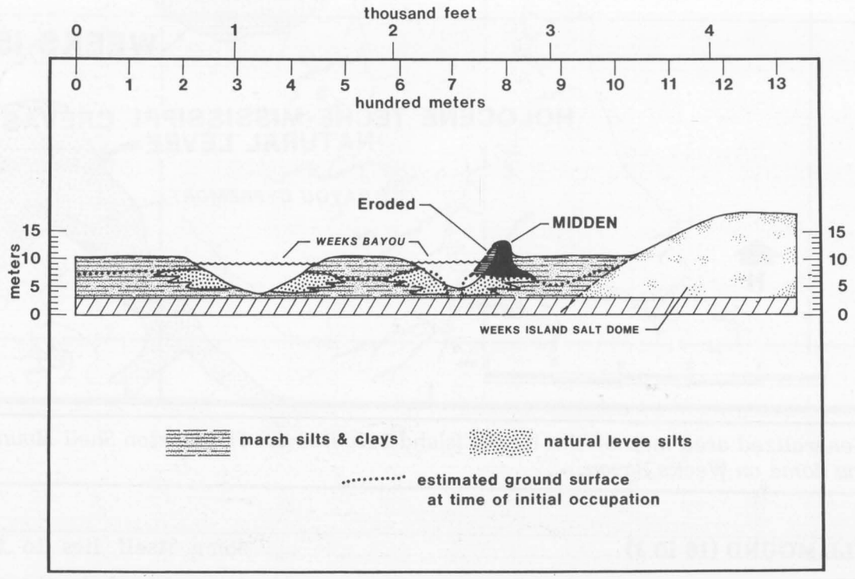


Figure 2-39. *Cross section through the Weeks Island Salt Dome and the Morton Shell Mound (16 IB 3). Location of section shown in Figure 2-38.*

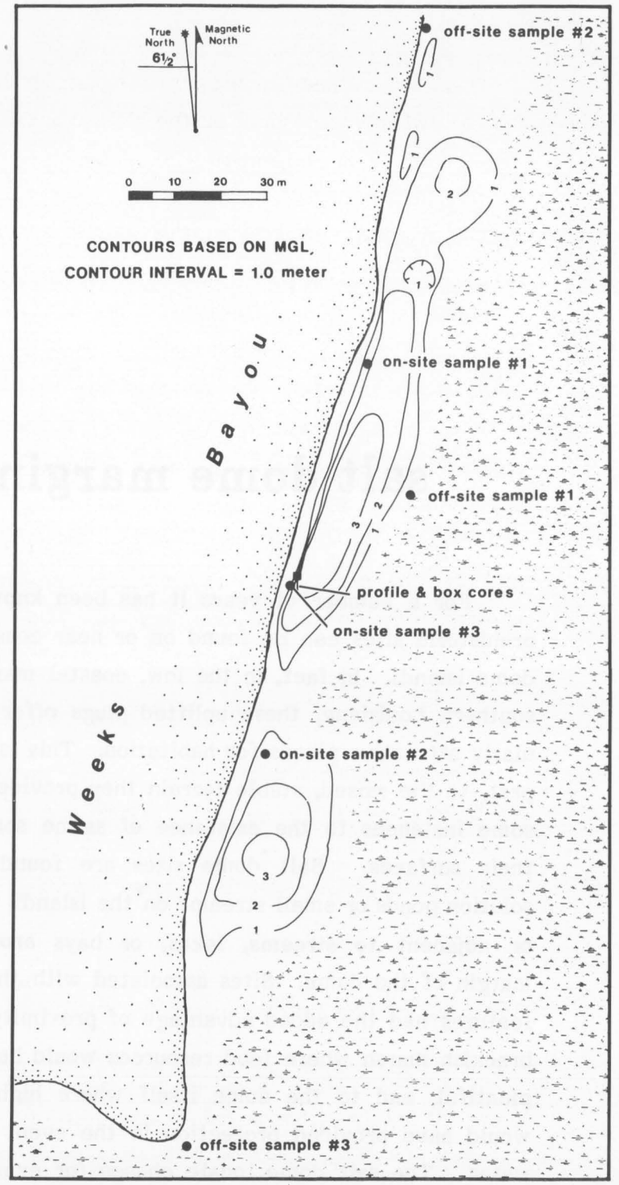


Figure 2-40. *The Morton Shell Mound (16 IB 3) showing the location of geochemical samples and box core (modified from Byrd 1974:Fig 1).*

estuarine margin

It has long been known that the margins flanking a marine estuary are some of the richest areas for site occurrence. The extreme biological productivity of the estuary provided the prehistoric inhabitants with abundant economic resources. The relatively high land surrounding the estuary, whether Pleistocene terrace, barrier-spit complex, or early Holocene terrace, offered stable areas for permanent villages and seasonal camps. A particularly favored spot for sites would be at points along the estuary escarpment where bayous or rivers impinged against the wall. These waterways allowed access to the estuary and to the Gulf, and also offered a transportation route up and down the estuary and its possible inland riverine valley counterpart. The estuary margins themselves may be marked by low escarpments which can be defined by bathymetry and sub-bottom profiles.

Two estuary margin sites have been chosen for study under the present research objectives. These are Cedarland Plantation (22 HA 506) and Jackson Landing, also known as Mulatto Bayou (22 HA 500), Hancock County, Mississippi.

CEDARLAND PLANTATION (22 HA 506)

The Cedarland Plantation site is perhaps the best known of the 15 sites examined in this study. It is also the only pure Late Archaic site (circa 3000-1500 B.C.) examined and as such offers an excellent analog to possible submerged sites on the OCS.

The site is a semi-circular, stratified, oyster shell and earth midden situated on a relict Pleistocene-age

Figure 2-41. *An estuarine margin site setting. Looking west along the edge of the Jackson Landing site (22 HA 500).*

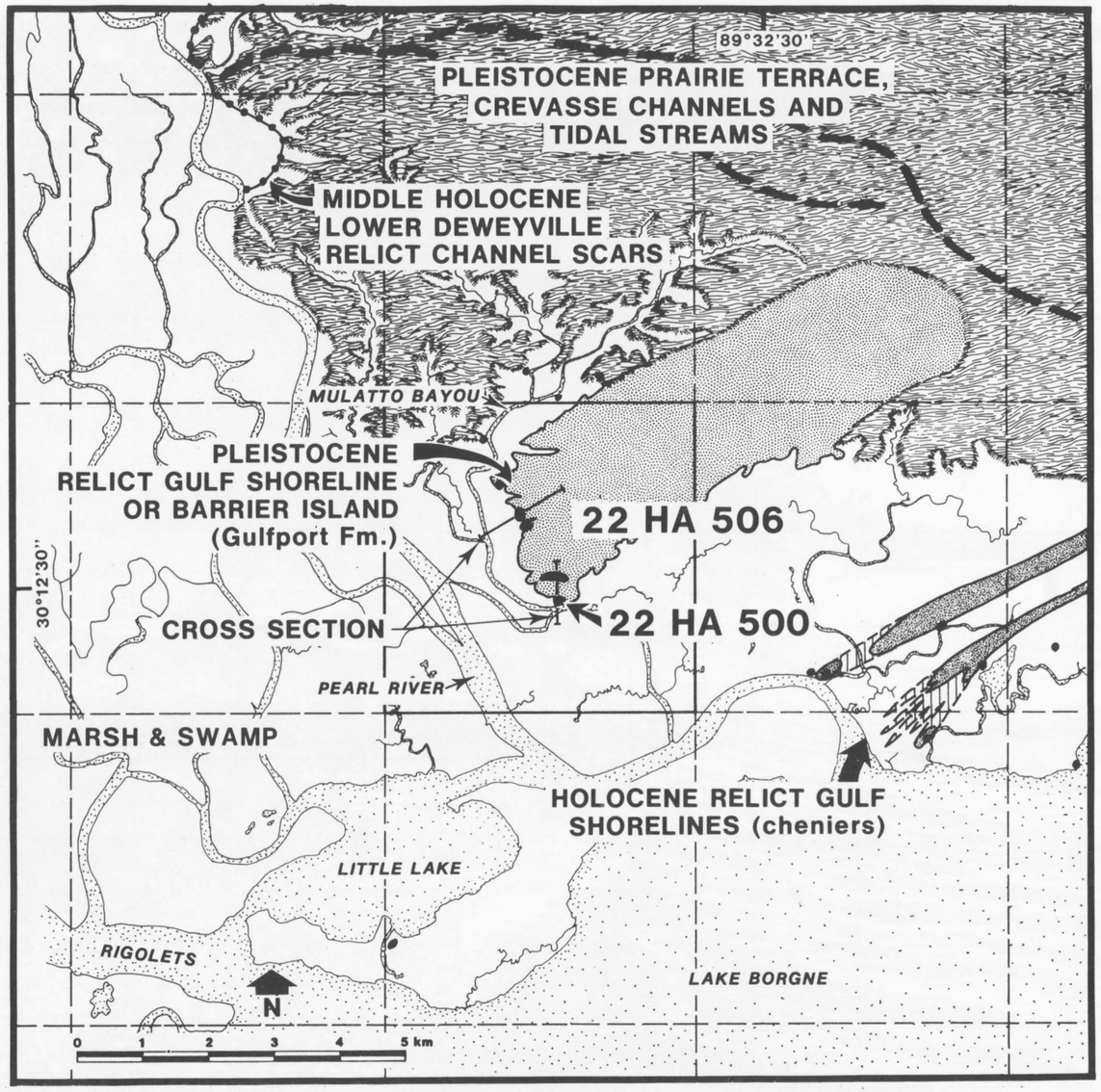


Figure 2-42. *Pleistocene and Holocene features along the eastern margin of the Pearl River Estuary. The Cedarland Plantation (22 HA 506) and Jackson Landing (22 HA 500) sites are situated atop a Pleistocene-age barrier island.*

beach ridge which forms part of the eastern side of the extensive Pearl River Estuary. A look at the area map shows that one three-mile-square lease block would probably provide data on the escarpment and its position with respect to the lowlands to the west, but it would be necessary to study data from adjacent lease blocks to identify the large estuary and its intricate pattern of streams.

As noted, Cedarland is basically composed of two strata. The lower stratum is predominantly oyster shell with a rich intermixing of faunal remains and artifacts. The upper stratum consists of black, organically-stained sand. Both layers contained numerous, small clay-lined hearths.

Located just south of Cedarland is the Claiborne site (22 HA 501), a Poverty Point-age locale. It has been demonstrated that an occupation and cultural

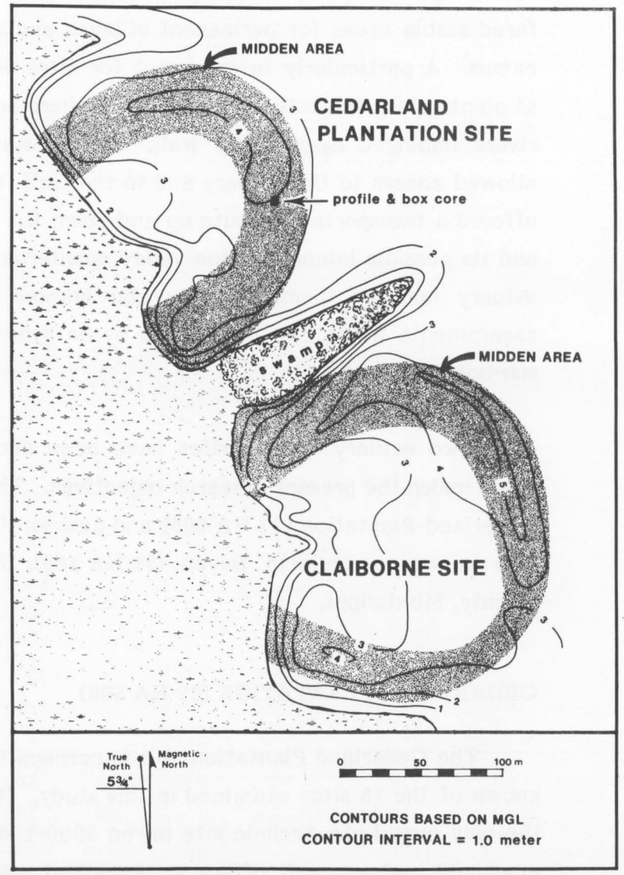


Figure 2-43. *Map of Cedarland Plantation (22 HA 506) and its nearby neighbor, the Claiborne site (22 HA 501) (modified from Gagliano and Webb 1970:Fig. 2).*

shift, occurring around 1200 B.C., took place between the inhabitants of Cedarland and Claiborne. A change in the resource base was also noted, as Claiborne is composed of an earth and Rangia midden. This suggests an alteration within the estuary from a saline to brackish water environment.

The Cedarland site measures about 165 m in diameter and attains a midden depth of 1.2 m. Today the site is completely destroyed, but soil samples collected in the 1960s by Gagliano were used in the present analysis.

References:

Gagliano 1963, 1979; Gagliano and Webb 1970; Webb 1977; Coastal Environments, Inc. 1977.

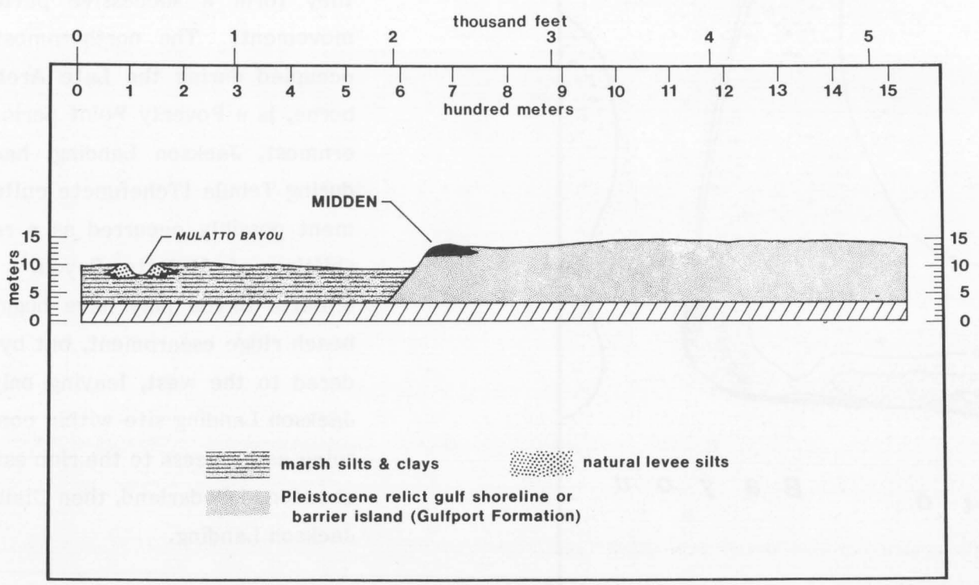


Figure 2-44. *Cross section through the Pleistocene barrier island upon which the Cedarland Plantation site (22 HA 506) is located. Section location is shown in Figure 2-42.*

JACKSON LANDING (MULATTO BAYOU) (22 HA 500)

Located on the southwestern tip of the same Pleistocene-age beach ridge as Cedarland Plantation, the Jackson Landing site provides data on the second locus associated with an estuary margin. Because of the site's position on the ancient beach formation, it, like Cedarland, provides data on sites which may be associated with similar beach ridge features on the OCS. In addition, because Jackson Bayou is only about 1.5 km south-southeast of Cedarland, both sites provide information on the Pearl River Estuary, at different stages in the estuary's development. Cedarland was occupied while the estuary was receiving a heavy influx of saltwater, while Jackson Landing was initially occupied much later, after the estuary had become brackish.

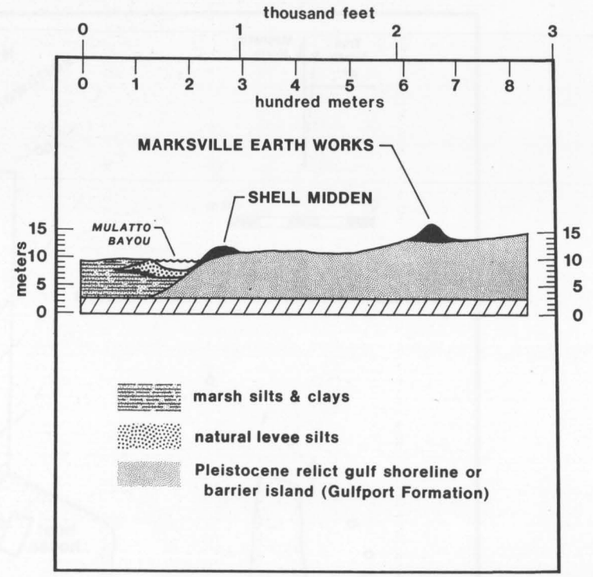


Figure 2-45. *Cross section through the Jackson Landing site (22 HA 500) and the Marksville Earthworks (22 HA 515), both located atop the Pleistocene barrier island on the edge of the Pearl River Estuary. Section location shown in Figure 2-42.*

The Jackson Landing site consists of a mound, middens, and an earthwork. Near Mulatto Bayou is a moderate-sized Rangia shell midden, partly wave-washed and partly dredged. About 80 m north of the shell pile is a pyramidal earth mound with a fairly distinct ramp still visible on its southern face. The shell midden covers an area measuring about 175x60 m and is 1 m high. The mound is approximately 60x70 m and 1.2 m high.

Situated to the northwest of the mound is the remnant of a fairly impressive earthwork (not fully illustrated) which at one time may have formed a semi-circular ring across the northern portion of the site. One box core was taken from this feature to provide data relevant to such structures. It is listed as box

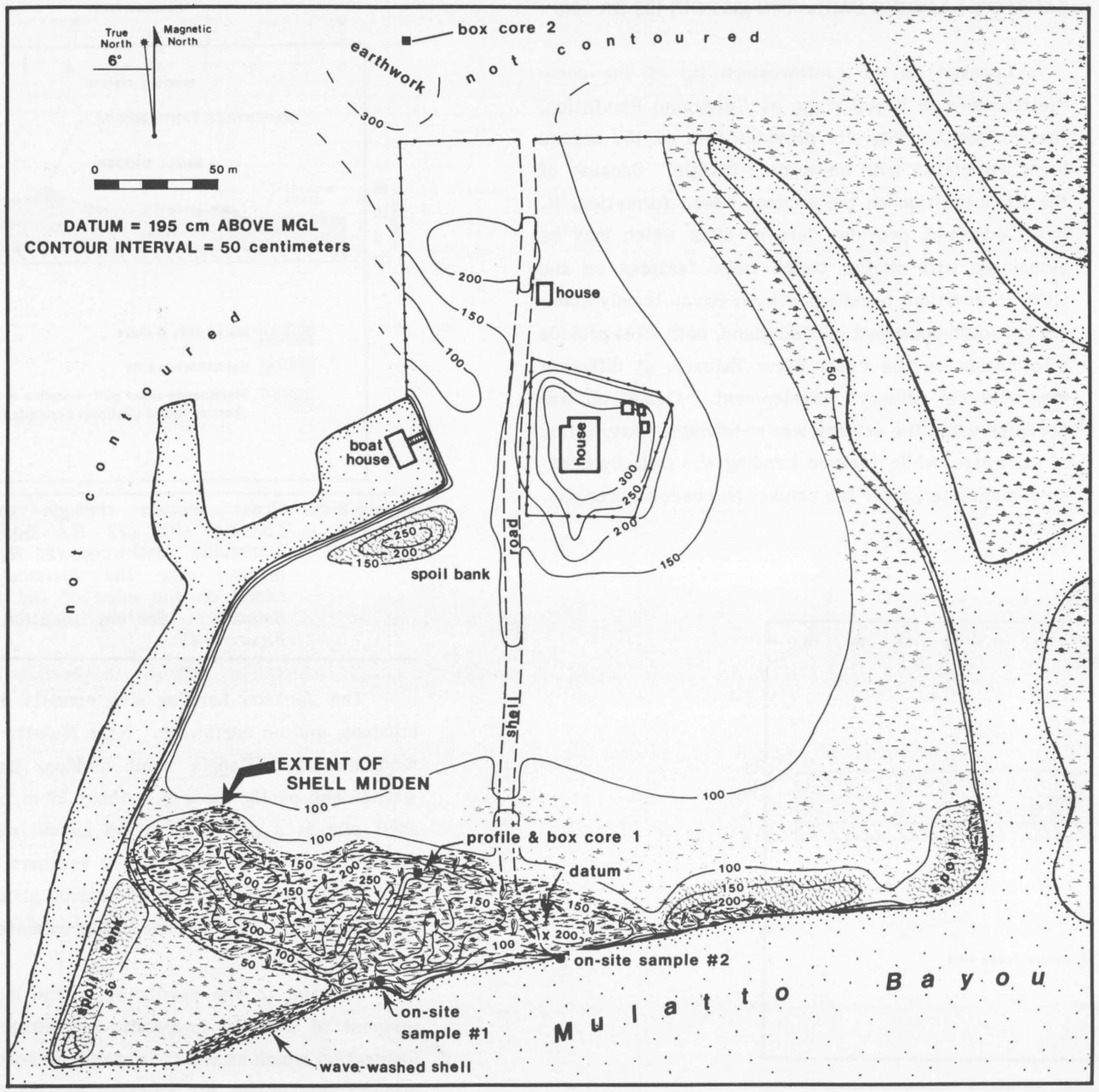


Figure 2-46. *The Jackson Landing site (22 HA 500) showing location of shell midden and pyramidal mound.*

core 2 for site 22 HA 500. It should be noted that the Mississippi Department of Archives and History has recently assigned to the earthwork a different site number, 22 HA 515. Excavations into the earthwork, reported by Mark Williams, have revealed that it is prehistoric and can be related to the late Marksville period (circa A.D. 200-400). The feature presently measures 490 m long, 30 m wide, and 6 m high. It was constructed of soils from the Pleistocene beach ridge and as such has an extremely sandy matrix.

Known occupations of the site include an initial Tchefuncte culture component followed by Marksville, Baytown, Coles Creek, Plaquemine, Mississippian, and historic Indian components. This is interesting in light of the fact that as one examines the three large sites on the western edge of the Pleistocene beach ridge, they form a successive pattern of occupation and movement. The northernmost site, Cedarland, was occupied during the Late Archaic period; next, Claiborne, is a Poverty Point period site; while the southernmost, Jackson Landing, had its initial occupation during Tchula (Tchefuncte culture) times. This movement possibly occurred as a reaction to the constant shifting of Mulatto Bayou. In the Late Archaic, Mulatto Bayou may have hugged the edge of the old beach ridge escarpment, but by Tchula times it meandered to the west, leaving only that portion near the Jackson Landing site within contact of the bluff. Pursuing easy access to the rich estuary, the Indians simply abandoned Cedarland, then Claiborne, finally settling at Jackson Landing.

References:

Wailes 1852; McIntire 1958; Gagliano 1963, 1979; Phillips 1970; Williams 1974, n.d.

channel on pleistocene terrace

One of the possible site-landform relationships which is likely to occur on the OCS is that of sites along the margin of incised Pleistocene stream valleys. It is well known that during the Pleistocene, when sea level was hundreds of meters lower than present, alluvial deposits extended out onto the continental shelf. As water level varied through time, either falling or rising, streams and rivers incised into existing floodplains or filled entrenched channels, thus forming new floodplains. Such a series of incised and filled channels is identifiable using today's bathymetery and subbottom profiles. Since early populations utilized the margins of these valleys, as evidenced by known terrestrial sites (Coastal Environments, Inc. 1977:334-335), it is possible that their remains can be found in bottom core samples. In order to gain a better understanding of the type of site believed to be associated with a Pleistocene stream valley or channel margin, the Bayou Blue site (16 AL 1) was selected for analysis. This site is situated on the edge of a small valley escarpment on the Pleistocene Prairie terrace in Allen Parish, Louisiana.

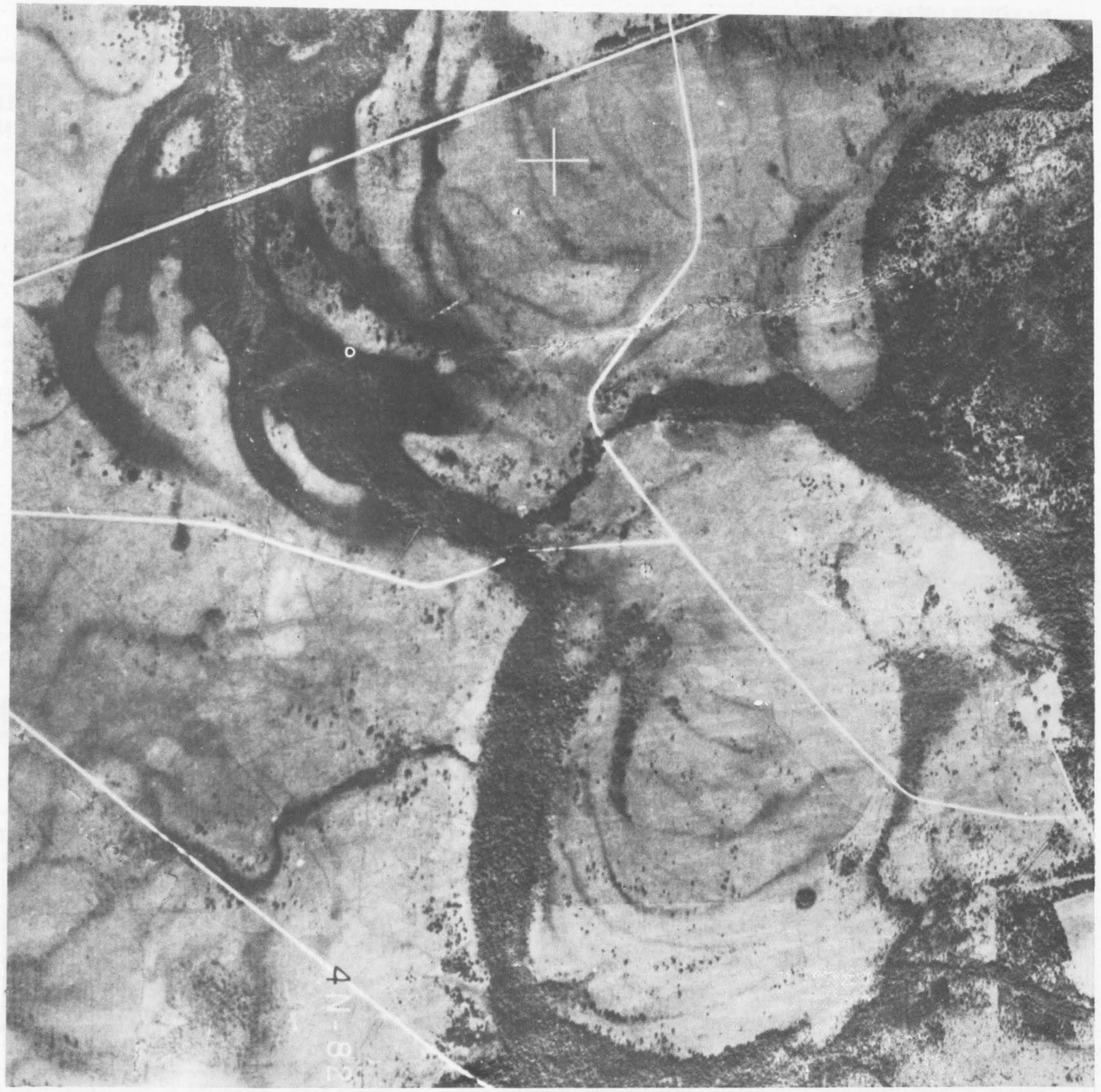


Figure 2-47. *Relict channel scars on the Pleistocene terrace in southeastern Louisiana.*

BAYOU BLUE (16 AL 1)

The Bayou Blue site is located within an area of complicated late Pleistocene (Pre-Prairie and Prairie terrace) landforms. It is situated on the Prairie terrace, fronting the Holocene valley of Bayou Blue. This valley may have formed within the channel of an earlier Prairie course of the Calcasieu River, however, this is only a tentative suggestion. To the west of the site, nevertheless, are definite relict meander belts of the Prairie-Calcasieu, while the modern Calcasieu is only a few kilometers farther west.

Perhaps one of the most striking series of channels to cross-cut the site area can be related to the Prairie-Red River. Although the Red River today flows into the Mississippi River near the latitude of Natchez, Mississippi, it swung to the southwest during the late Pleistocene and formed a delta in southwestern Louisiana. An interesting fact concerning the Prairie-Red and Prairie-Calcasieu is that both apparently flowed through the region simultaneously. To the south and west of Bayou Blue are indications that first the Calcasieu flowed south, then the Red west, then the Calcasieu, etc. These activities have formed a vast floodplain in the area.

Through the process of gradual uplift the entire region was raised and modern bayous and rivers began to incise into the older Prairie floodplain. The former channels of the Prairie-Red and Calcasieu are, thus, today marked by higher elevations where their natural levees remain, and by still-extant depressions which mark the actual ancient channels. At times these depressions can contain water.

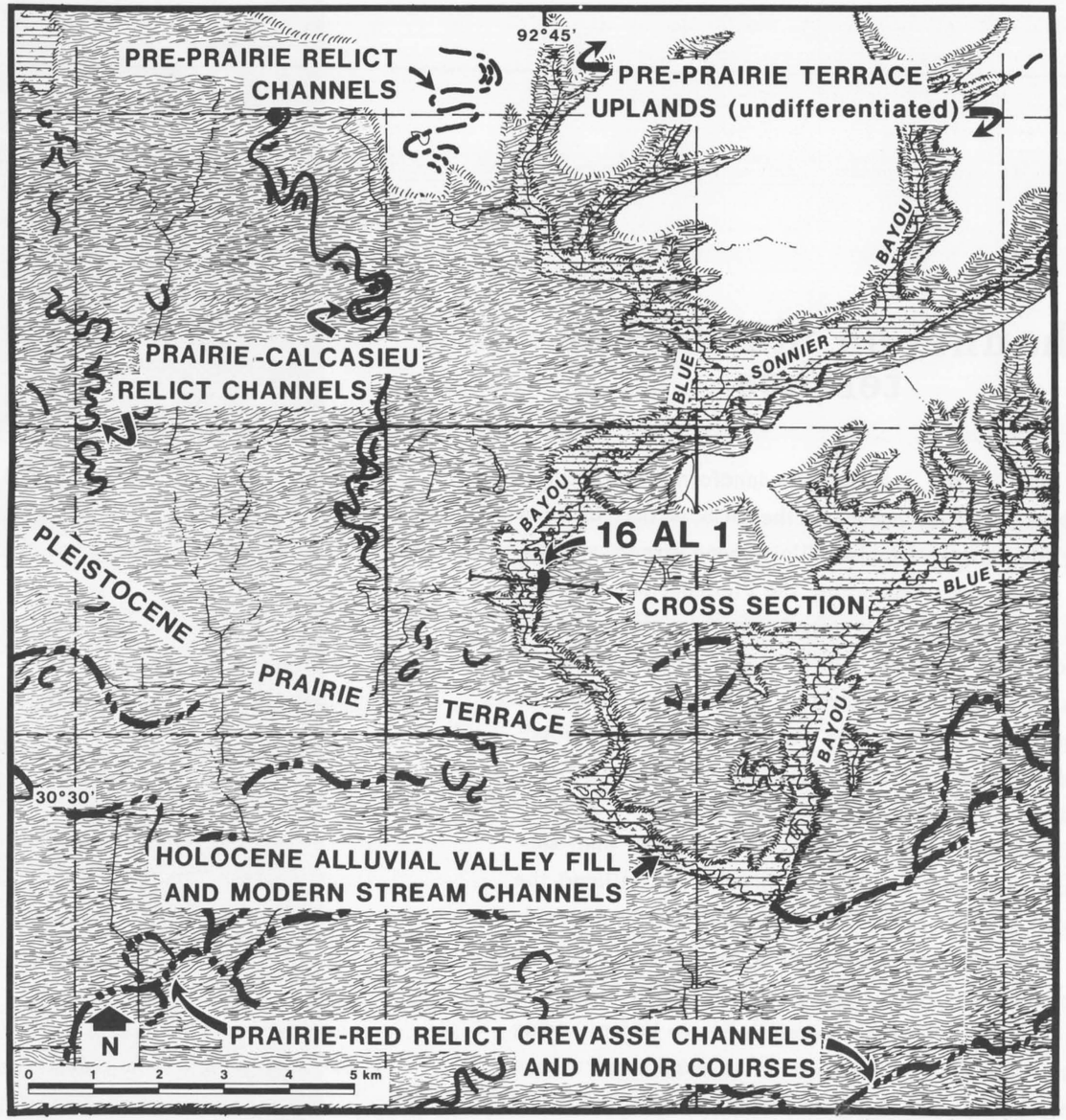


Figure 2-48. *Location of the Bayou Blue site (16 AL 1) on the edge of the Prairie terrace overlooking the incised channel of the modern Bayou Blue. The area is noted for its complex network of relict channels of the Prairie-Red and Prairie-Calcasieu.*

The Bayou Blue site probably became inhabited long after the Calcasieu and Red had shifted to their present locations. However, the landforms they left behind and the escarpment at the site overlooking the Holocene-Bayou Blue channel, if occuring on the OCS, would be identifiable using both bathymetry and sub-bottom profiles. In addition, Bayou Blue is felt to be a good representative of a type of Archaic-age site which may exist on the OCS.

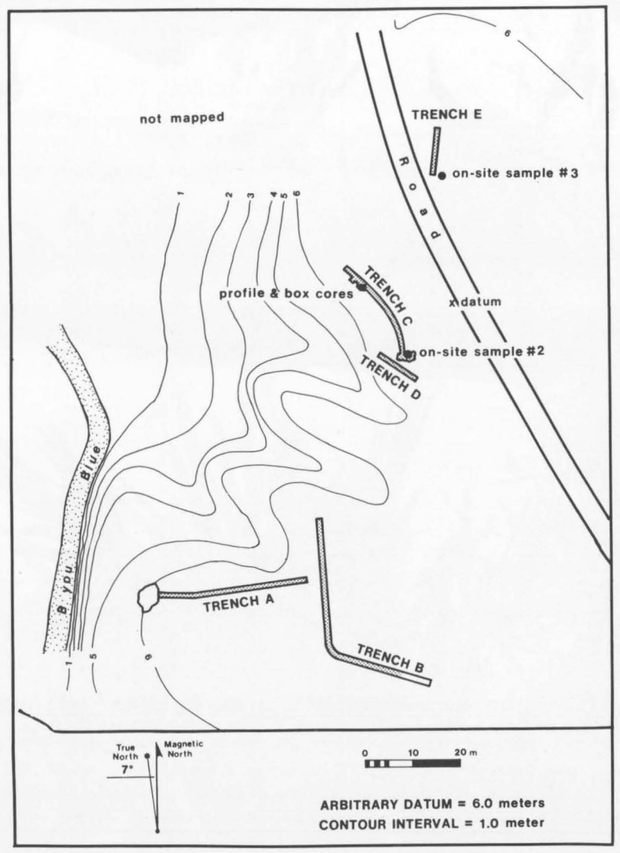


Figure 2-49. *Map of a portion of the Bayou Blue site (16 AL 1) showing backhoe trenches along the edge of the terrace.*

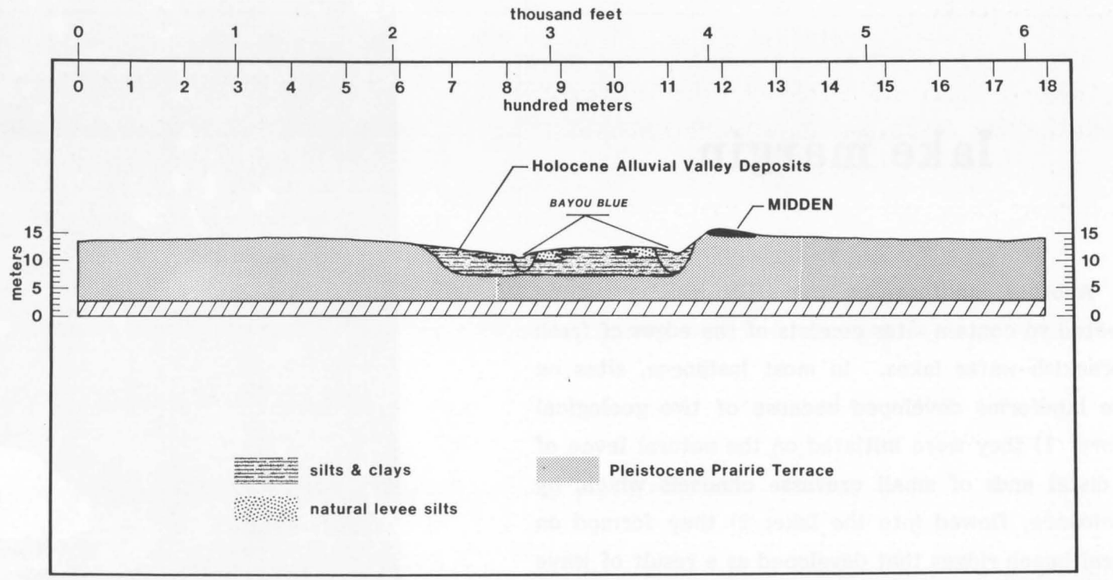


Figure 2-50. *Cross section through the incised Holocene valley of Bayou Blue and the surrounding Prairie terrace. Location of section shown in Figure 2-48.*

The site presently covers a large area along the bluff overlooking Bayou Blue, about 320 m long by 100 m wide. Cultural deposits extend to a depth of approximately 70 cm.

Stratigraphy within the cultural zone is fairly simple. A brown silt unit, 40 cm thick and containing numerous lithic remains, marks the lowest level of the site. It rests atop the Prairie terrace soils which are composed of mottled orange and tan silty clays. Above the lithic zone is a 15 cm thick stratum of yellowish brown silt containing ceramics. Another ceramic component, 15-20 cm thick, consisting of dark yellowish brown silt, makes up the latest level.

Excavations at the site, conducted intermittently by Wallace Stroud of Elton, Louisiana, have revealed that Bayou Blue was possibly inhabited by Late Paleo-Indian peoples (circa 8000-6000 B.C.). However, the first firm occupation occurred during the Early Archaic period (circa 6000-5000 B.C.). This occupation continued, obviously very sporadically, through Late Archaic, and into ceramic periods. Because of the poor preservation of most of the early ceramics, it is presently impossible to ascertain what cultural groups created them. A Plaquemine-like component is evident, though, in the upper level of the site. Also existing at Bayou Blue is a late nineteenth century component possibly related to the historic Coushatta Indians.

References:

Coastal Environments, Inc. 1977; Wiseman et al. 1979; Weinstein et al. 1979.

lake margin

Another landform on the OCS which may be expected to contain sites consists of the edges of fresh or brackish water lakes. In most instances, sites on these landforms developed because of two geological factors: 1) they were initiated on the natural levee of the distal ends of small crevasse channels which, by coincidence, flowed into the lake; 2) they formed on natural beach ridges that developed as a result of wave action and the redeposition of lake shells and bottom sediment. In some cases, a natural beach may be formed by the reworking of the distal ends of crevasse channels.

The economic advantages of a lake-edge site are many. The Indians could exploit the environment of not only the lake, but also the surrounding marshes and natural levees of nearby rivers and bayous. An ideal location for a site would be at the confluence of a river and the lake, thereby providing easy acccess to the neighboring faunal and floral communities.

The present study looked at one lakeshore site, The Temple (16 LF 4), located in Lafourche Parish, southeast Louisiana. This site was at one time a well-known landmark of the region and is identified on several early maps of the 1800s. Commercial shell dredging in the 1940s and subsequent erosional wave action from Lake Salvador have left little of the once-impressive site intact.

Figure 2-51. *A lake margin setting typical of coastal Louisiana.*

THE TEMPLE (16 LF 4)

The Temple is located today at the junction of Bayou des Allemands and Lake Salvador, and it is likely that this was the geographical situation throughout most of the site's history. However, it is possible that the initial occupation of the site commenced upon the now-submerged natural levee of the Bayou Petit Crevasse channel, shown north of the site on the area map. Later crevasse channels emanating from the Lafourche-Mississippi flowed eastward into Lake Salvador. Two of these entered the lake adjacent to the site along its southern margin, while the larger Bayou Matherne Distributary built a lacustrine delta out into the lake. The proximity of these channels, plus the developing Bayou des Allemands course, undoubtedly provided for the continued favorable conditions over the 1700 years that the site was occupied.

Today the Temple consists of a badly eroded remnant and associated wave-washed beach deposit. While prehistoric temple mounds are certainly not anticipated on the OCS, the site was selected for sampling and study because it represents one of the largest known prehistoric shell deposits in the Mississippi deltaic plain. The original site would have been of sufficient size to appear on batyhymetric records and sub-bottom profiles if the site were submerged.

The intact mound remnant now measures 43 m long, 15 m wide, and stands 4.2 m above MGL. Because

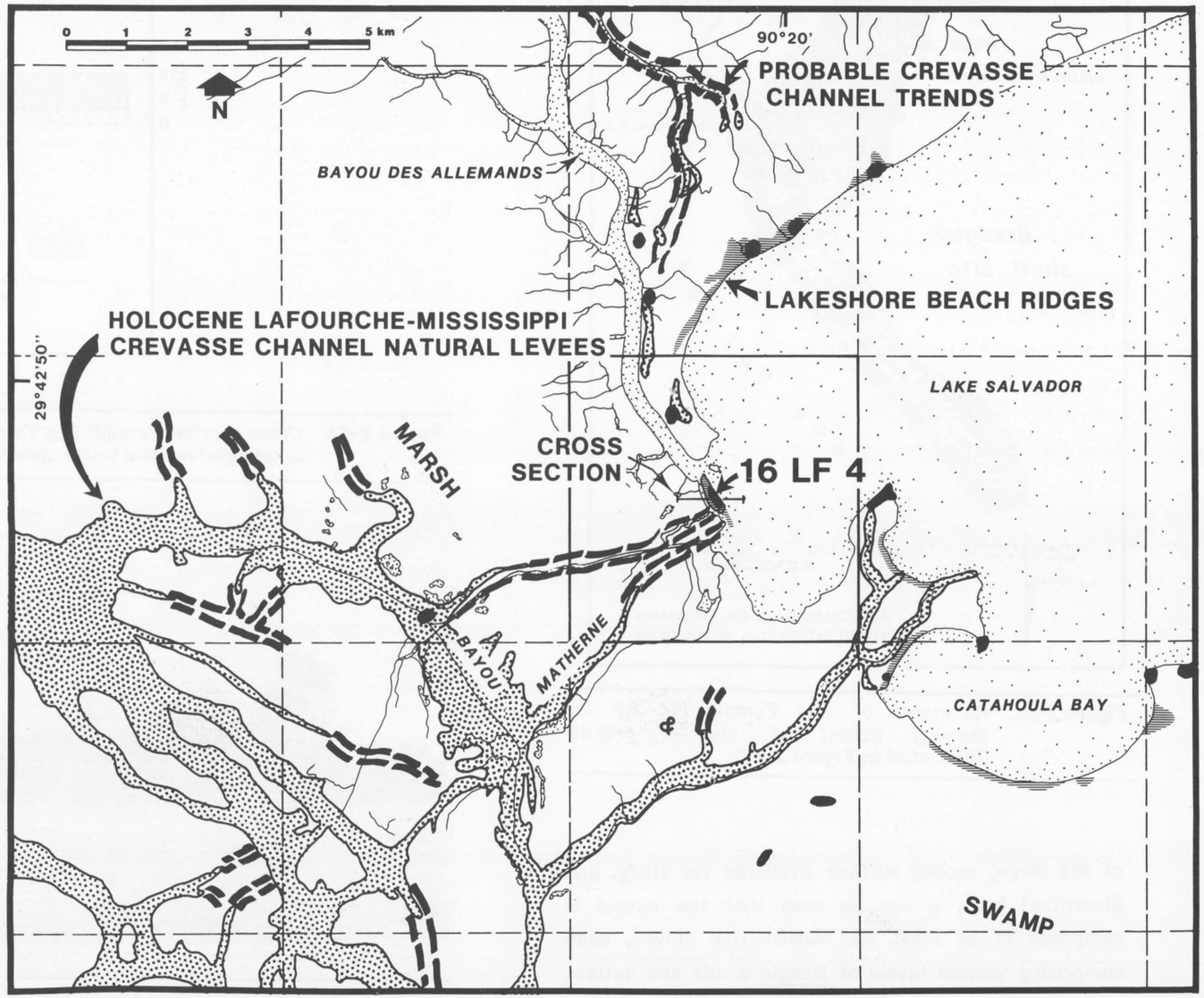


Figure 2-52. *The Temple (16 LF 4) situated at the edge of Lake Salvador. The site is probably resting atop natural levees of several combined crevasse channels, the earliest of which entered the region from the north.*

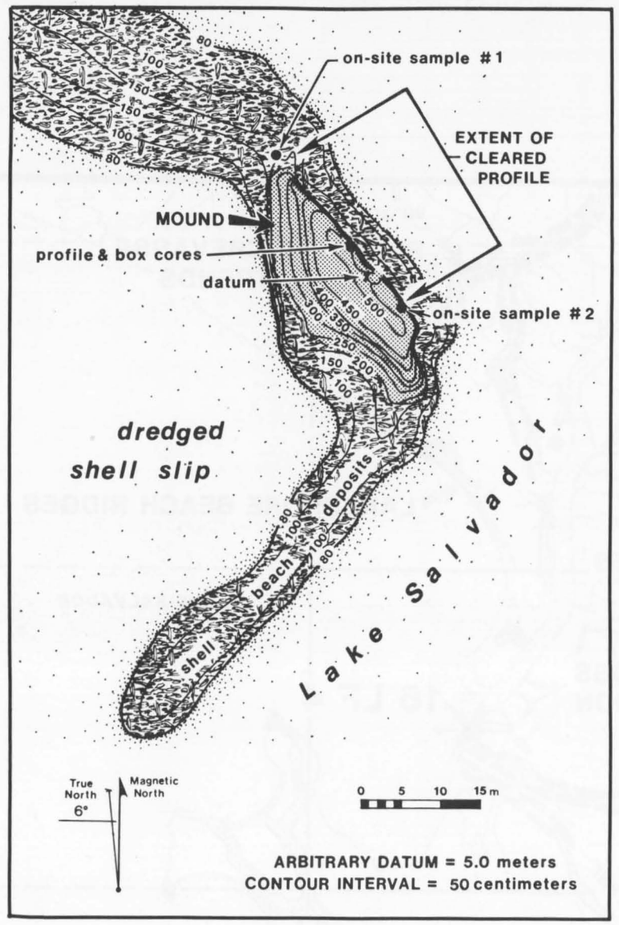


Figure 2-53. *Remnants of The Temple (16 LF 4). showing extent of cleared profile illustrated in Figure 2-56.*

of the large, eroded surface available for study, and illustrated here, it can be seen that the mound is composed of at least six construction stages, each comprising various levels of Rangia shells and natural levee earth. In a few cases, freshwater Unio shells were noted. Living floors, trash pits, post molds, and one burial were also present.

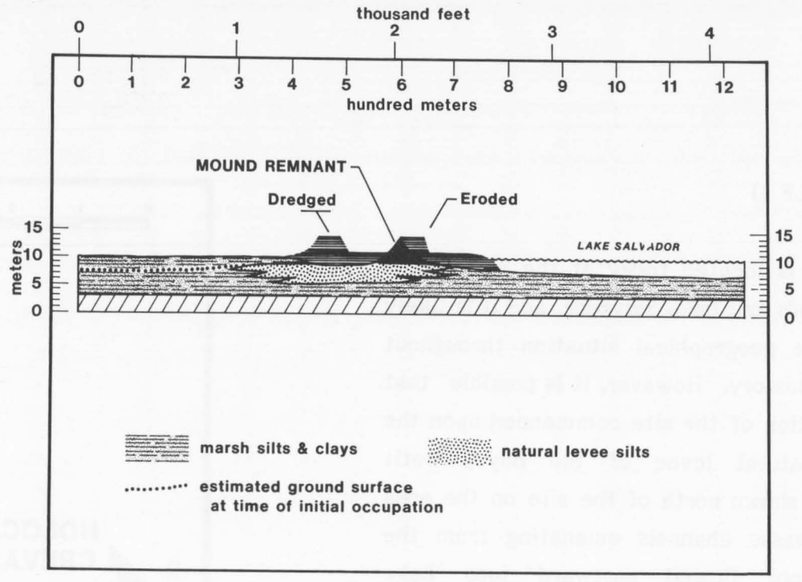


Figure 2-54. *Cross section through The Temple (16 LF 4) showing dredged and eroded portions of the site and the probable, submerged natural levee upon which it rests. Location of section shown in Figure 2-52.*

Figure 2-55. *The eroded face of The Temple (16 LF 4) as seen from Lake Salvador. View to the west. Date 7/18/79.*

Based on previous information, especially that of McIntire (1958), an initial Tchefuncte culture (circa 500-1 B.C.) component has been identified at the site. This, in turn, was followed by occupations spanning the entire pottery sequence, terminating with a large Mississippian component. A recent radiocarbon determination of 1235 ±100 (A.D. 715) was obtained on charcoal from a hearth in construction stage 3 (Forrest Travirca 1981, personal communication).

References:

Hughes 1843; McIntire 1958; Phillips 1970; Haag 1971; Swanson 1975; Neuman 1977; Gagliano et al. 1979.

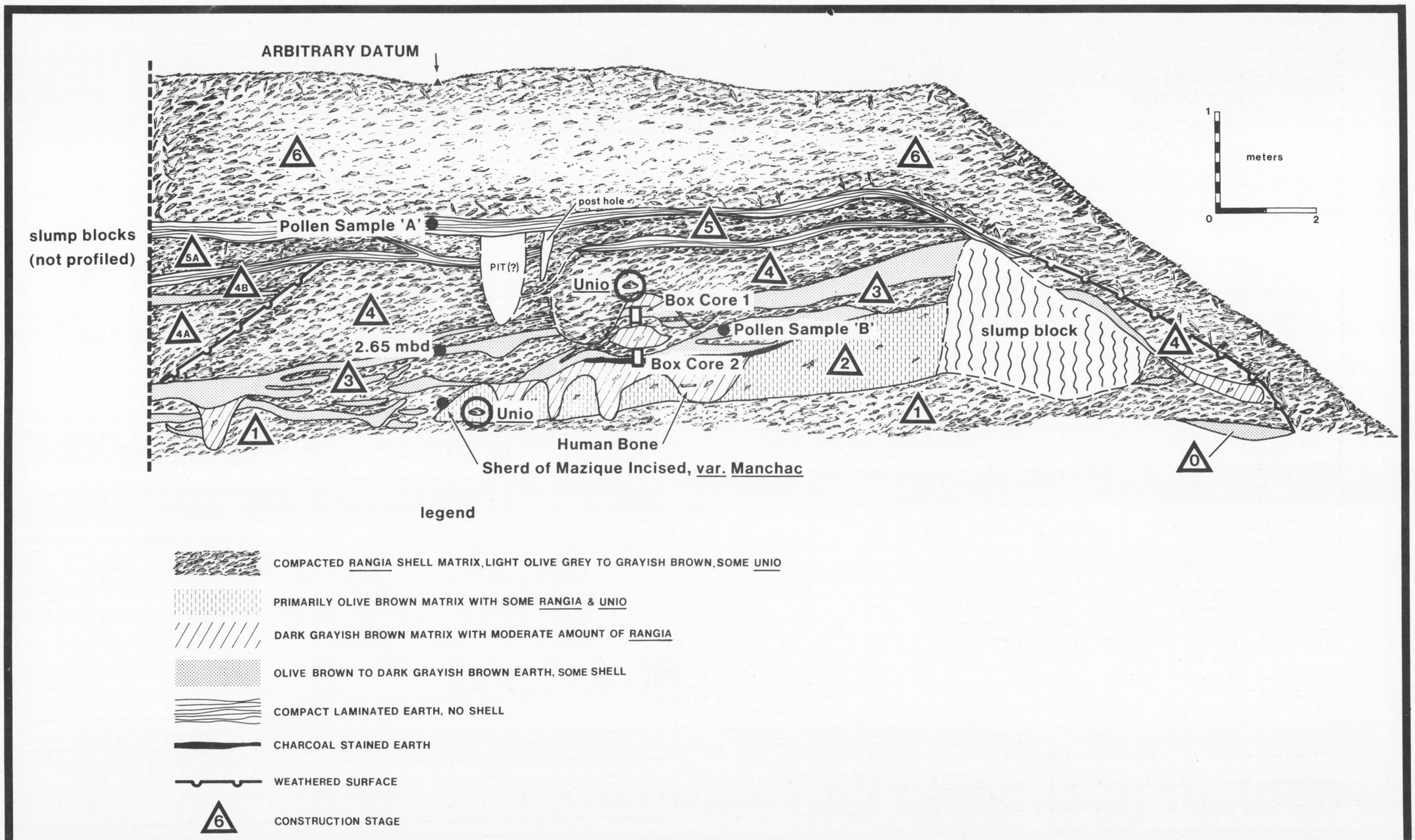


Figure 2-56. Profile along the eroded edge of The Temple (16 LF 4), clearly indicating the various construction stages, pits, burials, and living floors associated with its development. Location of profile shown in Figure 2-53.

CHAPTER III

MACRO-SEDIMENTARY CHARACTERISTICS

Sediment is defined as particulate material that has been deposited in a fluid medium. The fluid is usually water, but aeolian sediments are also common. Sedimentary rocks consist of lithified sediments. When fragments of pre-existing rocks are eroded and redeposited, they are called clastic sedimentary rocks. When composed of particles derived from plants and animals they are termed organic sedimentary rocks. These include coal, many limestones, and bone deposits. Ironstones, evaporites, and others formed by chemical processes are called chemical sedimentary rocks. As stated previously, the characteristics of sedimentary rocks reflect the kind and intensity of processes active during deposition, as well as those which may have modified the rock after deposition.

Archaeological deposits represent a special case of sediments in which human processes were active during deposition. Artifacts, objects which show clear evidence of human workmanship, are the most unequivocal indicators of human process in archaeological deposits. In some instances, archaeological deposits may be composed almost exclusively of artifacts, as in a mound of bricks or the chipping floor of a lithic workshop. More commonly, however, artifacts are less abundant constituents and are reduced to the status of inclusions in a sedimentary matrix. It is this type of deposit with which this report is concerned.*

In addition to artifacts and clastic sediments, various kinds of faunal and floral remains are frequently associated with archaeological deposits. While some of this material may have been introduced into the site area by natural processes, much was often the result of food procurement activities. The term "ecofact" is useful to distinguish faunal and floral remains deposited as a result of human activity from those resulting from natural sedimentary processes.

*Midden deposit is a general term often used to describe this type of archaeological deposit. Jennings (1974) defines a midden as an "...accumulation of refuse near a habitation site or dwelling." Joukowsky (1980) considers it to be a mound, of shell, pottery, tools, and ash refuse used by food gatherers (also known as a kitchen midden).

Archaeological deposits, then, can be thought of as a combination of artifacts, ecofacts, and clastic sedimentary particles. As illustrated in Figure 3-1, the proportions of the three basic elements can be expected to vary greatly. Usually, the higher the percentage of artifacts and/or ecofacts in the total volume of the sample, the more apparent the effect of human process (Figure 3-1, Points A and B). Conversely, a predominance of clastic sediment particles suggests that human process indicators will be overshadowed by natural process indicators (Figure 3-1, Point C).

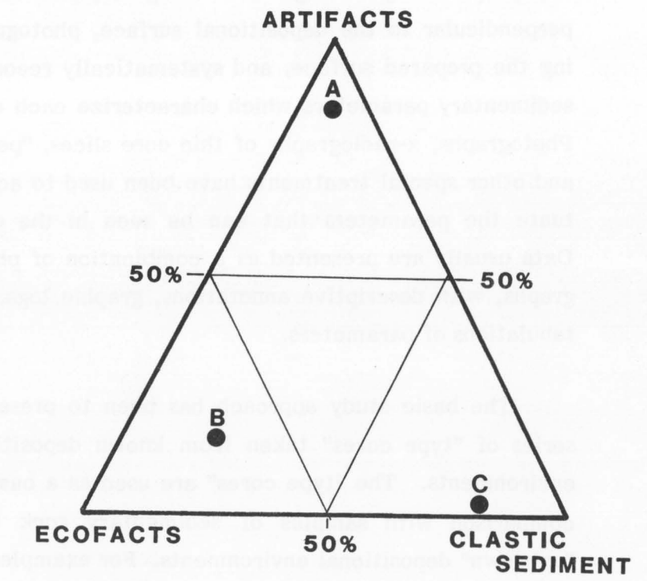


Figure 3-1. *Basic elements forming archaeological deposits.*

The mark of human process can be left in the sedimentary record in other ways besides gross composition. Minor sedimentary structures, inclusions, color, and other sedimentary parameters that can be identified, described, classified, and measured from core-size samples may also serve to distinguish human

process from natural process. In this section of the report, a sedimentological approach will be used to evaluate macro-sedimentary parameters of vertical sections and box core samples.

Like archaeology, sedimentology is a discipline that is part science and part art. For the purpose of interpretation of depositional environments, and processes active during deposition, sedimentologists have sampled active depositional environments, usually with undisturbed shallow cores. In the laboratory the cores are prepared by slicing them along a plane that is perpendicular to the depositional surface, photographing the prepared surface, and systematically recording sedimentary parameters which characterize each core. Photographs, x-radiographs of thin core slices, "peels," and other special treatments have been used to accentuate the parameters that can be seen in the core. Data usually are presented as a combination of photographs, with descriptive annotations, graphic logs, and tabulations of parameters.

The basic study approach has been to present a series of "type cores" taken from known depositional environments. The "type cores" are used as a basis of comparison with samples of sedimentary rock from "unknown" depositional environments. For example, the unknown sample may be a core obtained from an exploratory oil well. The interpretation is enhanced by use of fossils, mineralogy, vertical sequences, and geometry of the sedimentary body from which the core or sample is taken. Even though the methodology is partially subjective, it has led to useful interpretations of ancient sedimentary rocks throughout the world and provides a basic tool in the search for oil, gas, coal, and other minerals of economic importance that are associated with sedimentary rocks.

"natural" depositional environments

Characteristics of sedimentary deposits from the major depositional environments of the northern Gulf region have been described and illustrated in the geological literature. Unfortunately there is no single, comprehensive source for this data, and it is beyond the scope of the present report to synthesize this information. However, as a guide to the reader, some key references are provided. These are grouped by depositional environment and indicate sources of illustrations and/or detailed descriptions of "type cores" as follows:

Mississippi Delta

Distributary Channel - Fisk 1947; Coleman 1966a
Point Bar - Fisk 1947; Frazier and Osanik 1969
Natural Levee - Fisk 1947; Coleman and Gagliano 1965; Coleman 1966
Marsh - Kolb and van Lopik 1958; Coleman and Gagliano 1965; Coleman 1966a; Kolb, Smith, and Silva 1975
Fresh Water Swamp - Fisk 1947; Kolb and van Lopik 1958; Coleman and Gagliano 1965; Coleman 1966a, 1966b; Krinitzsky and Smith 1969; Krinitzsky 1970
Mangrove Swamp - Kolb and van Lopik 1958
Lacustrine - Fisk 1947; Kolb and van Lopik 1958; Coleman and Gagliano 1965; Coleman 1966a, 1966b; Krinitzsky and Smith 1969; Krinitzsky 1970
Lacustrine Delta - Coleman 1966b
Delta Front - Coleman and Gagliano 1965; Kolb, Smith, and Silva 1975
Beach - Fisk 1947; Kolb and van Lopik 1958
Prodelta - Coleman and Gagliano 1965; Kolb, Smith, and Silva 1975
Mudflat - Coleman and Gagliano 1965
Oyster Reef - Kolb and van Lopik 1958; Coleman 1966b
Bay-Sound - Kolb and van Lopik 1958; Coleman and Gagliano 1965; Coleman 1966a
Nearshore Marine - Kolb and van Lopik 1958; Coleman 1966a; Kolb, Smith and Silva 1975
Open Gulf or Shelf - Curray 1960; Coleman and Gagliano 1965; Kolb, Smith, and Silva 1975
Braided Stream Deposits - Fisk 1947; Coleman 1966b
Weathered Pleistocene Surface - Fisk 1947

Guadalupe and Trinity Deltas

Channel - McEwen 1969; Donaldson, Martin, and Kanes 1970
Natural Levee - McEwen 1969; Donaldson, Martin, and Kanes 1970
Interdistributary Bay - McEwen 1969; Donaldson, Martin, and Kanes 1970

Delta Front - McEwen 1969; Donaldson, Martin, and Kanes 1970
Prodelta - McEwen 1969; Donaldson, Martin, and Kanes 1970
Bay - McEwen 1969; Donaldson, Martin, and Kanes 1970

Chenier Plain

Chenier - Byrne, LeRoy, and Riley 1959
Marsh - Byrne, LeRoy, and Riley 1959
Bay mouth - Byrne, LeRoy, and Riley 1959
Bay bottom and mudflat - Byrne, LeRoy, and Riley 1959; Coleman 1966a
Nearshore Marine (Gulf bottom) - Byrne, LeRoy, and Riley 1959
Basal transgressive deposits - Byrne, LeRoy, and Riley 1959

East and Central Texas Barrier Islands and Lagoon

Beach - Fisk 1959; Bernard, LeBlanc, and Major 1962

Shoreface - Fisk 1959, Bernard, LeBlanc, and Major 1962

Dune - Fisk 1959; Bernard, LeBlanc, and Major 1962

Shoreface - Fisk 1959; Bernard, LeBlanc, and Major 1962

Lagoon - Fisk 1959; Bernard, LeBlanc, and Major 1962

Bay or Sound - Fisk 1959; Bernard, LeBlanc, and Major 1962

Interdune Pond - Fisk 1959; Bernard, LeBlanc, and Major 1962

Interdune Swamp - Fisk 1959; Bernard, LeBlanc, and Major 1962

Clay Dune - Fisk 1959

Tidal Flat - Fisk 1959

Tidal Delta - Bernard, LeBlanc, and Major 1962

Weathered Pleistocene Surface - Bernard, LeBlanc, and Major 1962

archaeological deposits

The primary purpose of this section of the report is to present "type cores" and "type vertical sections" from the archaeological sites sampled. This is done through the use of: 1) annotated photographs of vertical profiles taken at the collection locales; 2) annotated photographs of prepared faces of box core samples; and 3) macro-sedimentary parameter data forms. A secondary purpose is to summarize macro-sedimentary characteristics of archaeological site samples and to compare these (to a limited extent) to natural sedimentary deposits.

Figures 3-2 through 3-21 show annotated photographs of selected vertical sections and box core samples from the fifteen sites studied. They are grouped into four categories based on macro-sedimentary characteristics of the cores. These are as follows: A) bedded sand and marine shell; B) Rangia shell; C) silt, sand, or silty clay with inclusions; and D) bone with inclusions. Tables 3-1 through 3-15 provide examples of logging sheets used for systematic comparison of the box-core samples. These provide for the classification of the major constituents of the sediment as well as inclusions. Additional descriptors include Munsell soil color chart notations, distribution of color within the core, bedding characteristics, and bioturbation (burrows, root molds, and other biogenic modifications of stratification). Parameter descriptors are arranged across the top row. They include occurrence (presence or absence), percentage classes, size (following the Wentworth scale), sorting, and particle condition. These descriptors are used in reference to both major constituents, but also may be used to characterize inclusions. The parameters presented in the tables represent the expected range of items to be found in core samples and are not all represented in each sample. Table 3-16 summarizes and compares the indicator parameters from the core samples studied.

CATEGORY A: BEDDED SAND AND MARINE SHELL

(Figures 3-2 through 3-4; Tables 3-1 through 3-3)

Shells of fresh, brackish, and marine invertebrates are a conspicuous part of the composition of 12 of the 15 sites sampled. Shell content ranges from scattered inclusions to approximately 90% of the total volume of the deposit. The shell falls into two types based on derivation: 1) shell related to the landform upon which the site is situated, and 2) shell brought into the site by the occupants. The deposits in this category are composed largely of shells of the first type. Basic composition of the barrier islands or chenier ridges upon which the sites were situated consists of a high percentage of reworked brackish and marine shell which is either interbedded with the archaeological deposits or has become incorporated within them. In such instances, the shell usually displays great species variation and includes forms from several depth zones on the shelf as well as from bay, lake, and marsh environments (Byrne, LeRoy, and Riley 1959).

Individual shells display signs of reworking and transport. Most are broken, almost all are rounded and abraded, and many have secondary mineral coatings or overgrowths or encrusting marine organisms (bryozoan colonies, barnacles, etc.). Holes drilled by carnivorous gastropods are also common. Some of this shell may be reworked into the archaeological deposit and may be mistaken for ecofacts.

The archaeological deposits within this category are basically gray, organic stained, well-sorted sands with inclusions of artifacts and ecofacts. They are relatively thin (not more than 30 cm usually) and homogenous. Contacts are gradational and indications of minor stratification are absent.

CATEGORY A

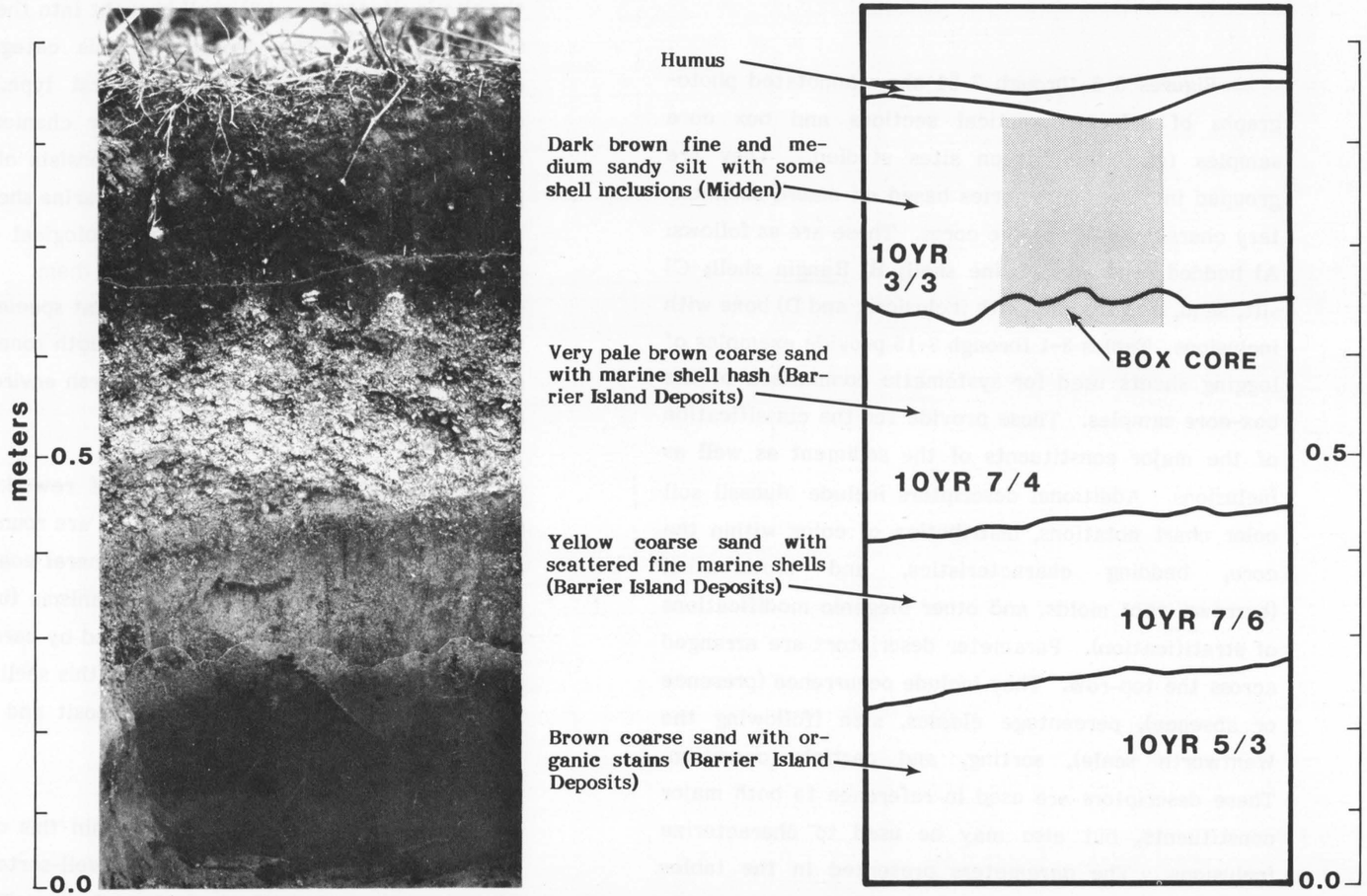

meters
0.5
0.0
Humus
Dark brown fine and medium sandy silt with some shell inclusions (Midden)
10YR 3/3
BOX CORE
Very pale brown coarse sand with marine shell hash (Barrier Island Deposits)
10YR 7/4
Yellow coarse sand with scattered fine marine shells (Barrier Island Deposits)
10YR 7/6
Brown coarse sand with organic stains (Barrier Island Deposits)
10YR 5/3
0.5
0.0

Figure 3-2A. *Vertical section from Mitchell Ridge site.*

MITCHELL RIDGE SITE (14 GV 66)

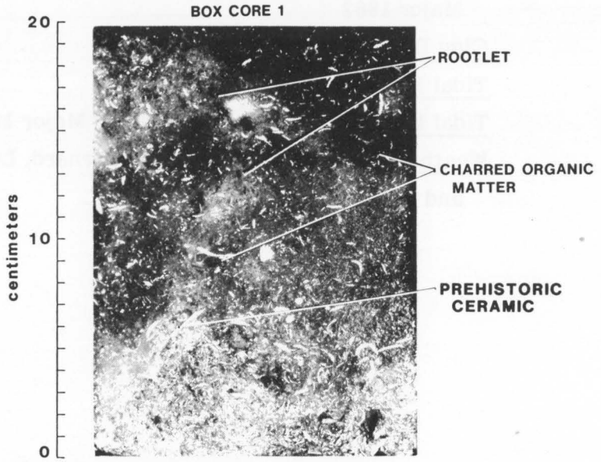


Figure 3-2B. *Box core sample from Mitchell Ridge site.*

DESCRIPTORS

INDICATOR PARAMETERS	OCCURRENCE	% TOTAL: 1: 10 to 19%	2: 20 to 29%	3: 30 to 39%	4: 40 to 49%	5: 50 to 59%	6: 60 to 69%	7: 70 to 79%	8: 80 to 89%	9: 90 to 100%	SIZE (Wentworth Scale): Cobbles (-6 to -8 phi units) 64 to 256 mm	Pebbles (-2 to -6 phi units) 4 to 64 mm	Granules (-1 to -2 phi units) 2 to 4 mm	Very Coarse Sand (0 to -1 phi units) 1 to 2 mm	Coarse Sand (1 to 0 phi units) .5 to 1 mm	Medium Sand (2 to 1 phi units) .25 to .5 mm	Fine Sand (3 to 2 phi units) .125 to .25 mm	Very Fine Sand (4 to 3 phi units) .0625 to .125 mm	Silt (8 to 4 phi units) .00391 to .0625 mm	Clay (8 phi units) .00391 mm	SORTING: Poorly Sorted	Well Sorted	Uniform	PARTICLE CONDITION: Whole	Broken	Rounded	Angular
MAJOR CONSTITUENTS (80% or more)																											
CLASTIC SILICATES																											
Gravel																											
Sand	●						●				●	●					●				●						
Silt																											
Clay																											
ORGANICS																											
Shell																											
Marine	●		●																		●				●	●	●
Crassostrea																											
Rangia																											
Freshwater pelecypods																											
Other																											
Bone																											
Large mammals																											
Small mammals																											
Reptiles																											
Fish																											
Birds																											
Other																											
Plant																											
Wood																											
Leaves, twigs, etc.																											
Peat																											
Fibrous or grassy																											
Woody																											
Other																											
ARTIFACTS																											
Ceramics																											
Pottery																											
Fired Clay																											
Stone																											
Bone																											
Shell																											
Wood or Fiber																											
INCLUSIONS (20% or less)																											
Artifacts																											
Ceramics																											
Pottery	●																										
Fired Clay																											
Stone																											
Bone																											
Shell																											
Wood or Fiber																											
Shell																											
Marine	●																				●				●	●	●
Crassostrea																											
Rangia																											
Freshwater pelecypods																											
Other																											
Bone																											
Wood																											
Ash																											
Charcoal	●																										
Sediment Balls																											
Nodules																											
Calcareous	R																										
Silicious																											
Iron																											
Other																											

INDICATOR PARAMETERS	OCCURRENCE	
COLOR		
Description	Gray to Pale Brown	
Munsell No.	10YR 5/1 to 10YR 6/3	
Homogenous		
Bedded	●	
Mottled		
Columnar		
BEDDING		
Thickness		
0-5 cm		
5-10 cm		
10-15 cm	●	
> 15 cm		
Contacts		
Sharp		
Burrowed		
Gradational	●	
Angular		
Horizontal	●	
Angular		
X-bedded		
Lenticular		
Distorted		
BIOTURBATION		
Large root molds		
Small root molds		
Rootlets	●	
Large animal burrows		
Small animal burrows		
Other		

R = REWORKED

Table 3-1. *Macro-sedimentary characteristics of box core 1 sample from the Mitchell Ridge site.*

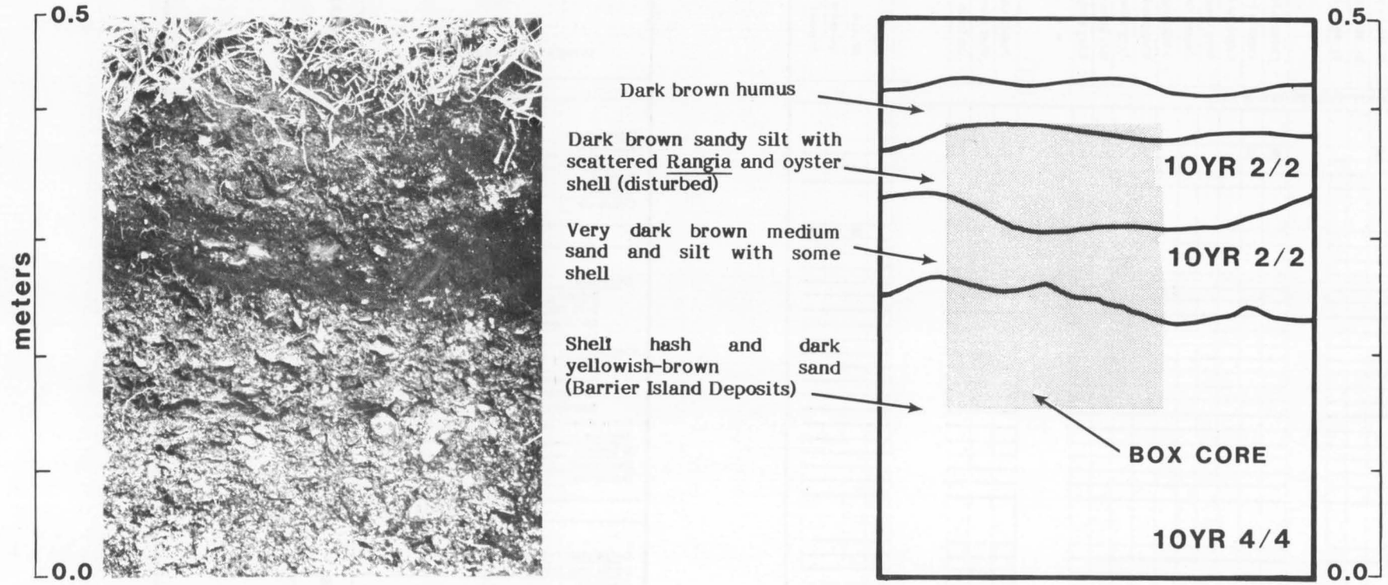


Figure 3-3A. *Vertical section from the Caplen site.*

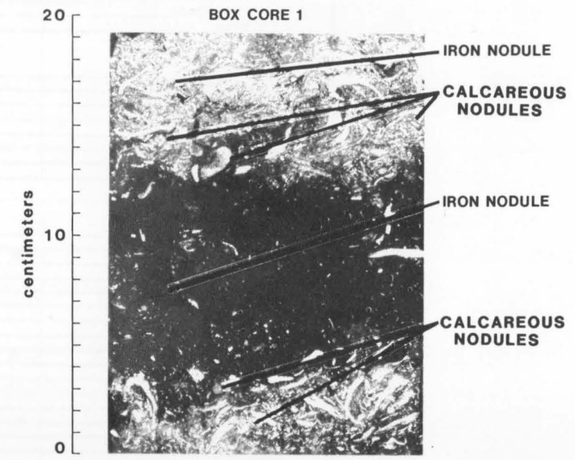


Figure 3-3B. *Box core sample from the Caplen site.*

DESCRIPTORS

INDICATOR PARAMETERS	OCCURRENCE	% TOTAL: 1: 10 to 19%	2: 20 to 29%	3: 30 to 39%	4: 40 to 49%	5: 50 to 59%	6: 60 to 69%	7: 70 to 79%	8: 80 to 89%	9: 90 to 100%	SIZE (Wentworth Scale): Cobbles (-6 to -8 phi units) 64 to 256 mm	Pebbles (-2 to -6 phi units) 4 to 64 mm	Granules (-1 to -2 phi units) 2 to 4 mm	Very Coarse Sand (0 to -1 phi units) 1 to 2 mm	Coarse Sand (1 to 0 phi units) .5 to 1 mm	Medium Sand (2 to 1 phi units) .25 to .5 mm	Fine Sand (3 to 2 phi units) .125 to .25 mm	Very Fine Sand (4 to 3 phi units) .0625 to .125 mm	Silt (8 to 4 phi units) .00391 to .0625 mm	Clay (8 phi units) .00391 mm	SORTING: Poorly Sorted	Well Sorted	Uniform	PARTICLE CONDITION: Whole	Broken	Rounded	Angular
MAJOR CONSTITUENTS (80% or more)																											
CLASTIC SILICATES																											
Gravel																											
Sand	●				●												●					●	●				
Silt																											
Clay																											
ORGANICS																											
Shell																											
Marine	●	●										●												●	●	●	
Crassostrea	●				●							●												●	●	●	●
Rangia	●	●										●													●	●	
Freshwater pelecypods																											
Other																											
Bone																											
Large mammals																											
Small mammals																											
Reptiles																											
Fish																											
Birds																											
Other																											
Plant																											
Wood																											
Leaves, twigs, etc.																											
Peat																											
Fibrous or grassy																											
Woody																											
Other																											
ARTIFACTS																											
Ceramics																											
Pottery																											
Fired Clay																											
Stone																											
Bone																											
Shell																											
Wood or Fiber																											
INCLUSIONS (20% or less)																											
Artifacts																											
Ceramics																											
Pottery	●																										
Fired Clay																											
Stone																											
Bone																											
Shell																											
Wood or Fiber																											
Shell																											
Marine																											
Crassostrea	●																										
Rangia																											
Freshwater pelecypods																											
Other																											
Bone																											
Wood																											
Ash																											
Charcoal																											
Sediment Balls																											
Nodules																											
Calcareous	R																										
Silicious																											
Iron	R																										
Other																											

INDICATOR PARAMETERS	OCCURRENCE
COLOR	
Description	Very Dark Gray Brown and Gray
Munsell No.	2.5Y 3/2 and 2.5Y 5/2
Homogenous	
Bedded	●
Mottled	
Columnar	
BEDDING	
Thickness	
0-5 cm	
5-10 cm	●
10-15 cm	
>15 cm	
Contacts	
Sharp	●
Burrowed	●
Gradational	
Angular	
Horizontal	●
Angular	
X-bedded	
Lenticular	
Distorted	
BIOTURBATION	
Large root molds	
Small root molds	
Rootlets	
Large animal burrows	
Small animal burrows	
Other	

R = REWORKED

Table 3-2. Macro-sedimentary characteristics of box core 1 sample from the Caplen site.

VEAZEY SITE
(16 VM 7,8)

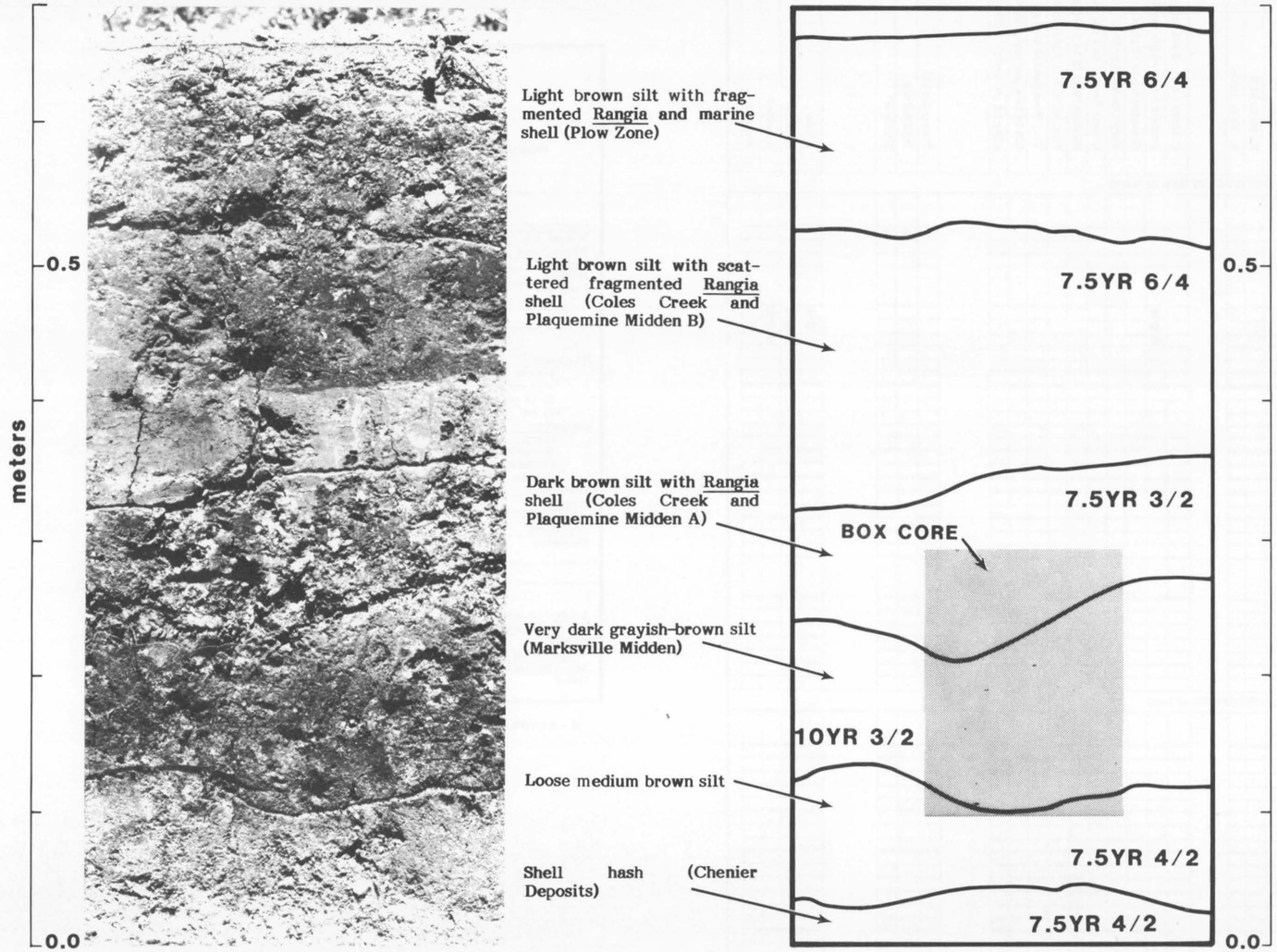


Figure 3-4A. *Vertical section from the Veazey site.*

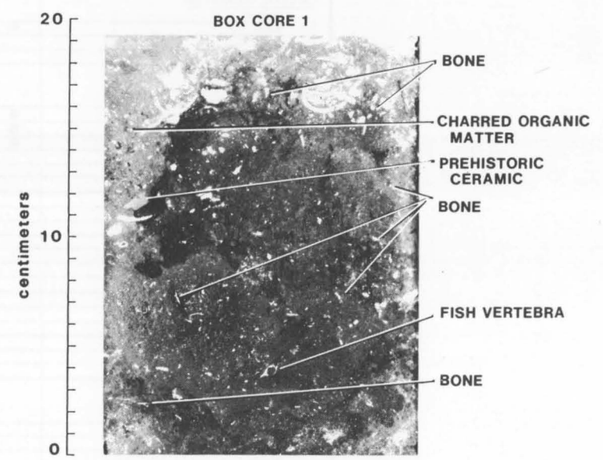


Figure 3-4B. *Box core sample from the Veazey site.*

DESCRIPTORS

INDICATOR PARAMETERS	OCCURRENCE	% TOTAL: 1: 10 to 19%	2: 20 to 29%	3: 30 to 39%	4: 40 to 49%	5: 50 to 59%	6: 60 to 69%	7: 70 to 79%	8: 80 to 89%	9: 90 to 100%	SIZE (Wentworth Scale): Cobbles (-6 to -8 phi units) 64 to 256 mm	Pebbles (-2 to -6 phi units) 4 to 64 mm	Granules (-1 to -2 phi units) 2 to 4 mm	Very Coarse Sand (0 to -1 phi units) 1 to 2 mm	Coarse Sand (1 to 0 phi units) .5 to 1 mm	Medium Sand (2 to 1 phi units) .25 to .5 mm	Fine Sand (3 to 2 phi units) .125 to .25 mm	Very Fine Sand (4 to 3 phi units) .0625 to .125 mm	Silt (8 to 4 phi units) .00391 to .0625 mm	Clay (8 phi units) .00391 mm	SORTING: Poorly Sorted	Well Sorted	Uniform	PARTICLE CONDITION: Whole	Broken	Rounded	Angular
MAJOR CONSTITUENTS (80% or more)																											
CLASTIC SILICATES																											
Gravel																											
Sand	●									●								●			●		●				
Silt																											
Clay																											
ORGANICS																											
Shell																											
Marine																											
Crassostrea																											
Rangia																											
Freshwater pelecypods																											
Other																											
Bone																											
Large mammals																											
Small mammals																											
Reptiles																											
Fish																											
Birds																											
Other																											
Plant																											
Wood																											
Leaves, twigs, etc.																											
Peat																											
Fibrous or grassy																											
Woody																											
Other																											
ARTIFACTS																											
Ceramics																											
Pottery																											
Fired Clay																											
Stone																											
Bone																											
Shell																											
Wood or Fiber																											
INCLUSIONS (20% or less)																											
Artifacts																											
Ceramics																											
Pottery	●																										
Fired Clay																											
Stone																											
Bone																											
Shell																											
Wood or Fiber																											
Shell																											
Marine	●											●									●				●	●	
Crassostrea																											
Rangia	R																										
Freshwater pelecypods												●															
Other																											
Bone	●																										
Wood																											
Ash																											
Charcoal	●																										
Sediment Balls																											
Nodules																											
Calcareous																											
Silicious																											
Iron																											
Other																											

INDICATOR PARAMETERS	OCCURRENCE	
COLOR		
Description	Gray	
Munsell No.	10YR 6/11	
Homogenous		
Bedded		
Mottled		
Columnar		
BEDDING		
Thickness		
0-5 cm		
5-10 cm		
10-15 cm		
>15 cm	●	
Contacts		
Sharp		
Burrowed		
Gradational	●	
Angular		
Horizontal	●	
Angular		
X-bedded		
Lenticular		
Distorted		
BIOTURBATION		
Large root molds		
Small root molds		
Rootlets		
Large animal burrows		
Small animal burrows		
Other		

Table 3-3. Macro-sedimentary characteristics of box core 1 sample from the Veazey site.

CATEGORY B: RANGIA SHELL

(Figures 3-5 through 3-12; Tables 3-4 through 3-9)

A major category of archaeological deposits from coastal sites consists of deposits composed primarily of shell ecofacts. Typically, one shell type predominates. Within the study area shells of the brackish water clam Rangia cuneata are by far the most common constituent of coastal zone sites of upper (river-influenced) estuaries. Shells of Crassostrea virginica are common in sites associated with lower estuaries and coastal lagoons, and various species of pelecypods which grow in freshwater coastal lakes (Unio sp.) are found in sites of the upper delta and freshwater marshlands. Along the Florida coast, middens composed of Busycon sp. and Mercenaria sp. have been reported. While the species of the shells have significance as environmental indicators, emphasis here is on the characteristics of the shells as indicators of depositional processes.

Consider, for example, the shell in a thick midden deposit such as the Morton Shell Mound (16 IB 3). Although the deposit is composed predominately of the single shell type Rangia cuneata, the midden profile exhibits well-defined, internal stratification. Bedding and other features are distinguished by variation in size, packing, condition of the individual shells (broken, crushed, burned, etc.), and percentage of nonshell matrix. Within the sequence there are large lenses of relatively clean, unbroken shell. Small lenses of articulated Rangia are relatively common. Carbonized remains of a net bag full of unopened Rangia were observed in a natural exposure at this site. These observations lead to the inference that clams were brought in as a food source, but for unknown reasons were not always utilized. It also is likely that some shell was introduced as fill to build up the site area. In much of the north-central Gulf region, shell is the most readily available coarse-grained sediment and is still widely used for building-site preparation and road metal.

In any event, lenses and beds of clean shell (little or no nonshell matrix) are common features of coastal middens. In such cases the shells tend to be relatively uniform in size. Analysis of growth rings from such uniform deposits provides a test for seasonality of harvest (Aten 1981). Growth ring analysis and other specific measurements of shells from unknown samples in which one species predominates provide an important test for human selection.

Frequently, clean, uniform shell grades upward into broken and crushed shell with a higher percentage of nonshell matrix and inclusions. The inclusions consist of ash lenses, bone, burned clay, and artifacts. The shell tends to be broken, crushed, and/or burned. In such situations the deposition rate was apparently lower and the intensity of human activity higher than in the lenses of clean, unbroken shell. Inferred processes included pedestrian activity and food processing (cleaning, cooking, etc.). In such activity areas thin soils often form, and burrowing by plant roots, insects, earthworms, and other organisms also may have been prevalent.

This sequence is repeated from site to site and is shown in idealized form in Figure 3-5. The contact between composite sets is sharp and well defined, but within the set change is usually gradational.

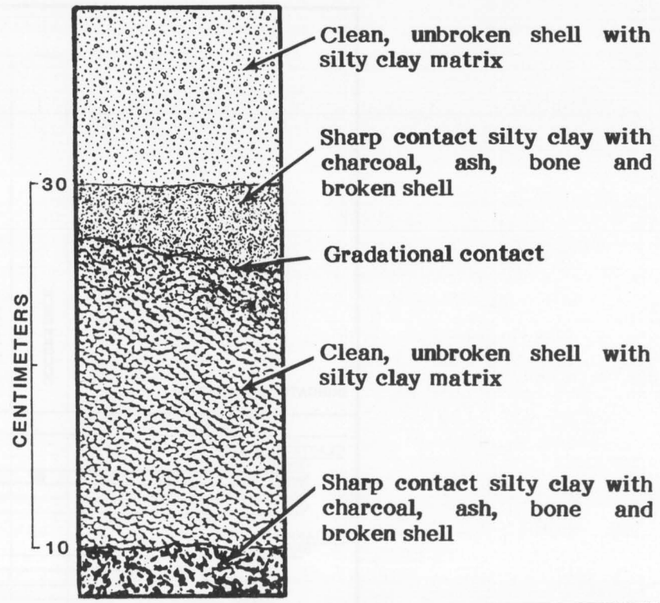

Clean, unbroken shell with silty clay matrix
Sharp contact silty clay with charcoal, ash, bone and broken shell
Gradational contact
Clean, unbroken shell with silty clay matrix
Sharp contact silty clay with charcoal, ash, bone and broken shell
30
10
CENTIMETERS

Figure 3-5. *Sequence of structures in a Rangia shell midden produced by alternating shell disposal areas and areas of more intensive activity.*

Burned areas are common in Rangia shell deposits. The shell is broken, darkened, and calcined. Ash and charcoal are usually evident. In some instances the calcined shell may be cemented by groundwater percolation to form "midden rock." Cemented midden rock occurs in irregular pieces 25 to 50 cm in their longest dimension and is somewhat resistant to erosion. Midden rock could be left as lag in the event that a site was destroyed by marine erosion (Figure 3-6).

Natural banks of Rangia shells resembling coastal shell middens are known from coastal Louisiana. A good example is a shell bank which formed during the 1947 hurricane near the mouth of Bayou Labranche on the south shore of Lake Pontchartrain. This bank was apparently derived from a rich, lake-bottom clam bed

which was thrown up by storm-generated waves. The bank was 1 m or more in thickness and 100 m or more in length. The shells were mature, clean, largely unbroken, well sorted, and with little nonshell matrix material.

Similar banks occur along the north shore of Lake Pontchartrain near the mouth of the Tangipahoa River. The Big Oak Island site (16 OR 6), a Tchula period (ca. 500 B.C. to A.D. 1) shell midden near the south shore of Lake Pontchartrain in Orleans Parish, Louisiana, was apparently situated on a natural Rangia bank. Kolb and van Lopik (1958) have reported the distribution of numerous natural Rangia banks exposed at the surface and in the shallow subsurface of the Mississippi deltaic plain.

Natural oyster reefs, which might also be mistaken for shell middens are even more common. Large reefs occur within the bays, lagoons, and sounds of the entire northern Gulf area (Parker 1960). Shells within natural oyster reefs may include a combination of clusters of shells in growth position and wave-washed, broken shell fragments. They are also likely to contain ancillary shell types associated with the reef habitat, such as Brachidontes recurvus and Crepidula plana, although these also occur in archaeological deposits composed predominantly of oyster shell.

Still another complicating factor is that natural reefs may become established around and upon shell middens. This has been noted in the St. Bernard subdelta area of the Mississippi River deltaic plain as well as in bays along the coast of Mississippi and Alabama. In such instances, spat may attach themselves to artifacts and other coarse constituents of the archaeological deposit exposed on the site surface.

Figure 3-6A. *Example of cemented "midden rock" from a coastal Louisiana site.*

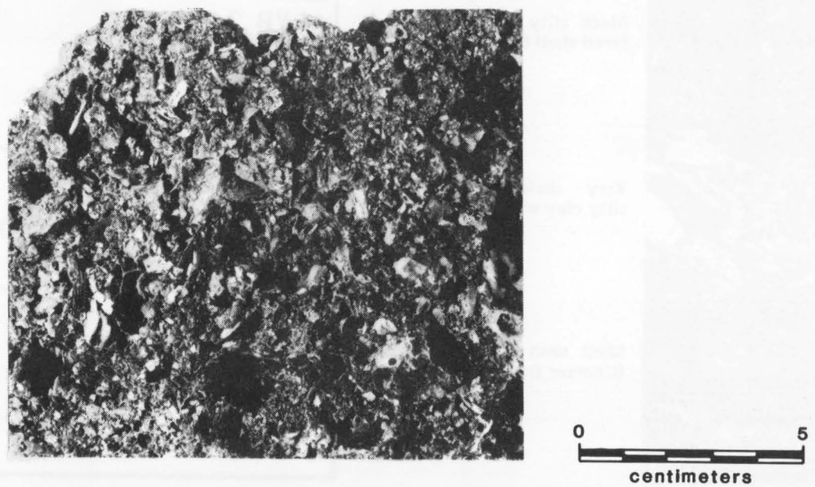


Figure 3-6B. *Enlargement of "midden rock" showing macro-sedimentary constituents.*

CATEGORY B

PIERRE CLEMENT SITE (16 CM 47)

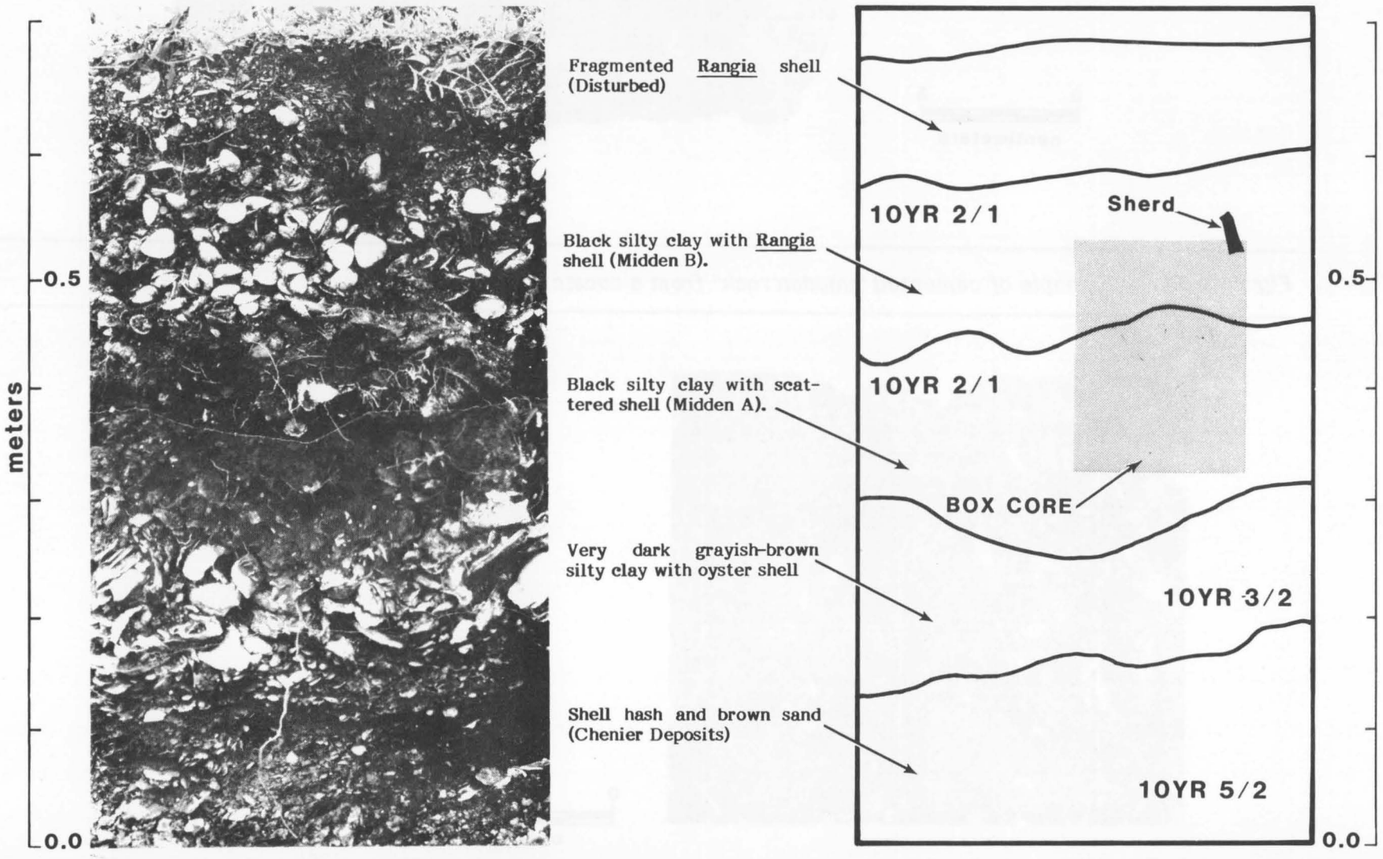


Figure 3-7A. Vertical section from the Pierre Clement site.

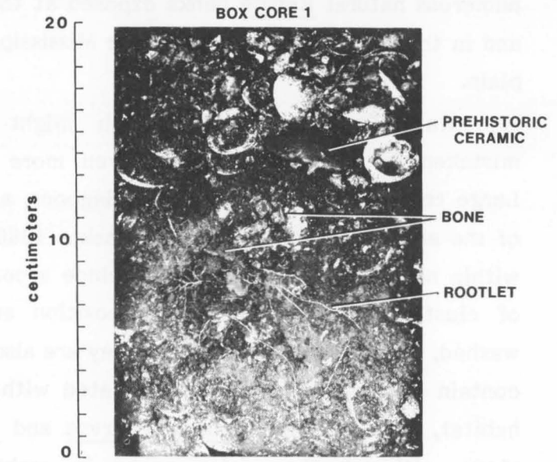


Figure 3-7B. Box Core sample from the Pierre Clement site.

DESCRIPTORS

INDICATOR PARAMETERS	OCCURRENCE	% TOTAL: 1: 10 to 19%	2: 20 to 29%	3: 30 to 39%	4: 40 to 49%	5: 50 to 59%	6: 60 to 69%	7: 70 to 79%	8: 80 to 89%	9: 90 to 100%	SIZE (Wentworth Scale): Cobbles (-6 to -8 phi units) 64 to 256 mm	Pebbles (-2 to -6 phi units) 4 to 64 mm	Granules (-1 to -2 phi units) 2 to 4 mm	Very Coarse Sand (0 to -1 phi units) 1 to 2 mm	Coarse Sand (1 to 0 phi units) .5 to 1 mm	Medium Sand (2 to 1 phi units) .25 to .5 mm	Fine Sand (3 to 2 phi units) .125 to .25 mm	Very Fine Sand (4 to 3 phi units) .0625 to .125 mm	Silt (8 to 4 phi units) .00391 to .0625 mm	Clay (8 phi units) .00391 mm	SORTING: Poorly Sorted	Well Sorted	Uniform	PARTICLE CONDITION: Whole	Broken	Rounded	Angular
MAJOR CONSTITUENTS (80% or more)																											
CLASTIC SILICATES																											
Gravel																											
Sand																											
Silt																											
Clay	●						●														●		●				
ORGANICS																											
Shell																											
Marine																											
Crassostrea	●	●									●	●									●			●			●
Rangia	●		●									●									●		●				●
Freshwater pelecypods																											
Other																											
Bone																											
Large mammals																											
Small mammals																											
Reptiles																											
Fish																											
Birds																											
Other																											
Plant																											
Wood																											
Leaves, twigs, etc.																											
Peat																											
Fibrous or grassy																											
Woody																											
Other																											
ARTIFACTS																											
Ceramics																											
Pottery																											
Fired Clay																											
Stone																											
Bone																											
Shell																											
Wood or Fiber																											
INCLUSIONS (20% or less)																											
Artifacts																											
Ceramics																											
Pottery	●																										
Fired Clay																											
Stone	●																										
Bone																											
Shell																											
Wood or Fiber																											
Shell																											
Marine																											
Crassostrea																											
Rangia																											
Freshwater pelecypods																											
Other																											
Bone	●																										
Wood																											
Ash																											
Charcoal																											
Sediment Balls																											
Nodules																											
Calcareous																											
Silicious																											
Iron																											
Other																											

INDICATOR PARAMETERS	OCCURRENCE	
COLOR		
Description	Dark Gray	
Munsell No.	5Y 4/1	
Homogenous	●	
Bedded		
Mottled		
Columnar		
BEDDING		
Thickness		
0-5 cm		
5-10 cm		
10-15 cm	●	
>15 cm		
Contacts		
Sharp		
Burrowed		
Gradational		
Angular		
Horizontal	●	
Angular		
X-bedded		
Lenticular		
Distorted		
BIOTURBATION		
Large root molds		
Small root molds	●	
Rootlets	●	
Large animal burrows		
Small animal burrows		
Other		

Table 3-4. *Macro-sedimentary characteristics of box core 1 sample from the Pierre Clement site.*

MORTON SHELL MOUND SITE
(16 IB 3)

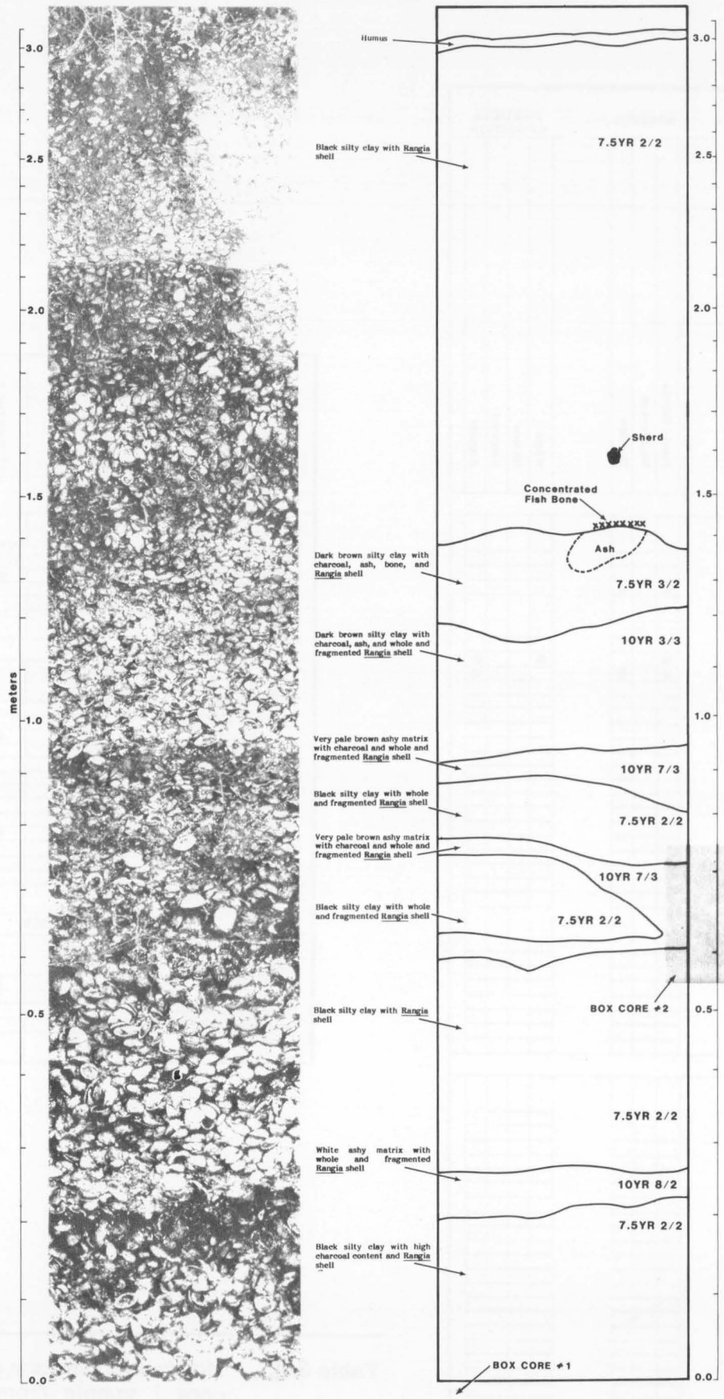

meters
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Humus
7.5YR 2/2
Black silty clay with Rangia shell
Sherd
Concentrated Fish Bone
Ash
Dark brown silty clay with charcoal, ash, bone, and Rangia shell
7.5YR 3/2
Dark brown silty clay with charcoal, ash, and whole and fragmented Rangia shell
10YR 3/3
Very pale brown ashy matrix with charcoal and whole and fragmented Rangia shell
10YR 7/3
Black silty clay with whole and fragmented Rangia shell
7.5YR 2/2
Very pale brown ashy matrix with charcoal and whole and fragmented Rangia shell
10YR 7/3
Black silty clay with whole and fragmented Rangia shell
7.5YR 2/2
BOX CORE #2
Black silty clay with Rangia shell
7.5YR 2/2
White ashy matrix with whole and fragmented Rangia shell
10YR 8/2
7.5YR 2/2
Black silty clay with high charcoal content and Rangia shell
BOX CORE #1

Figure 3-8A. *Vertical section from the Morton Shell Mound site.*

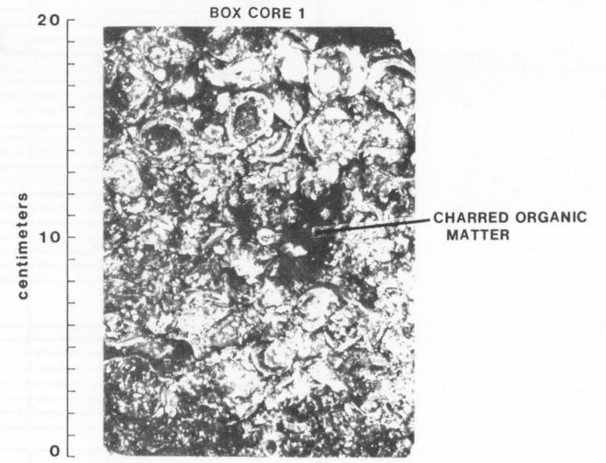


Figure 3-8B. *Box core sample from the Morton Shell Mound site.*

DESCRIPTORS

INDICATOR PARAMETERS	OCCURRENCE	% TOTAL: 1: 10 to 19%	2: 20 to 29%	3: 30 to 39%	4: 40 to 49%	5: 50 to 59%	6: 60 to 69%	7: 70 to 79%	8: 80 to 89%	9: 90 to 100%	SIZE (Wentworth Scale): Cobbles (-6 to -8 phi units) 64 to 256 mm	Pebbles (-2 to -6 phi units) 4 to 64 mm	Granules (-1 to -2 phi units) 2 to 4 mm	Very Coarse Sand (0 to -1 phi units) 1 to 2 mm	Coarse Sand (1 to 0 phi units) .5 to 1 mm	Medium Sand (2 to 1 phi units) .25 to .5 mm	Fine Sand (3 to 2 phi units) .125 to .25 mm	Very Fine Sand (4 to 3 phi units) .0625 to .125 mm	Silt (8 to 4 phi units) .00391 to .0625 mm	Clay (8 phi units) .00391 mm	SORTING: Poorly Sorted	Well Sorted	Uniform	PARTICLE CONDITION: Whole	Broken	Rounded	Angular
MAJOR CONSTITUENTS (80% or more)																											
CLASTIC SILICATES																											
Gravel																											
Sand																											
Silt	●			●																	●		●				
Clay																											
ORGANICS																											
Shell																											
Marine																											
Crassostrea																											
Rangia	●						●					●									●		●		●	●	●
Freshwater pelecypods																											
Other																											
Bone																											
Large mammals																											
Small mammals																											
Reptiles																											
Fish																											
Birds																											
Other																											
Plant																											
Wood																											
Leaves, twigs, etc.																											
Peat																											
Fibrous or grassy																											
Woody																											
Other																											
ARTIFACTS																											
Ceramics																											
Pottery																											
Fired Clay																											
Stone																											
Bone																											
Shell																											
Wood or Fiber																											
INCLUSIONS (20% or less)																											
Artifacts																											
Ceramics																											
Pottery																											
Fired Clay																											
Stone																											
Bone																											
Shell																											
Wood or Fiber																											
Shell																											
Marine																											
Crassostrea																											
Rangia																											
Freshwater pelecypods																											
Other																											
Bone																											
Wood	C																										
Ash	●																										
Charcoal	●												●														
Sediment Balls																											
Nodules																											
Calcareous																											
Silicious																											
Iron																											
Other																											

INDICATOR PARAMETERS	OCCURRENCE	
COLOR		
Description	Very Dark Gray	
Munsell No.	7.5YR 3/0	
Homogenous		
Bedded		
Mottled	●	
Columnar		
BEDDING		
Thickness		
0-5 cm		
5-10 cm		
10-15 cm		
> 15 cm	●	
Contacts		
Sharp		
Burrowed		
Gradational		
Angular		
Horizontal	●	
Angular		
X-bedded		
Lenticular		
Distorted		
BIOTURBATION		
Large root molds		
Small root molds		
Rootlets		
Large animal burrows		
Small animal burrows		
Other		

C = CHARRED

Table 3-5. *Macro-sedimentary characteristics of box core 2 sample from the Morton Shell Mound site.*

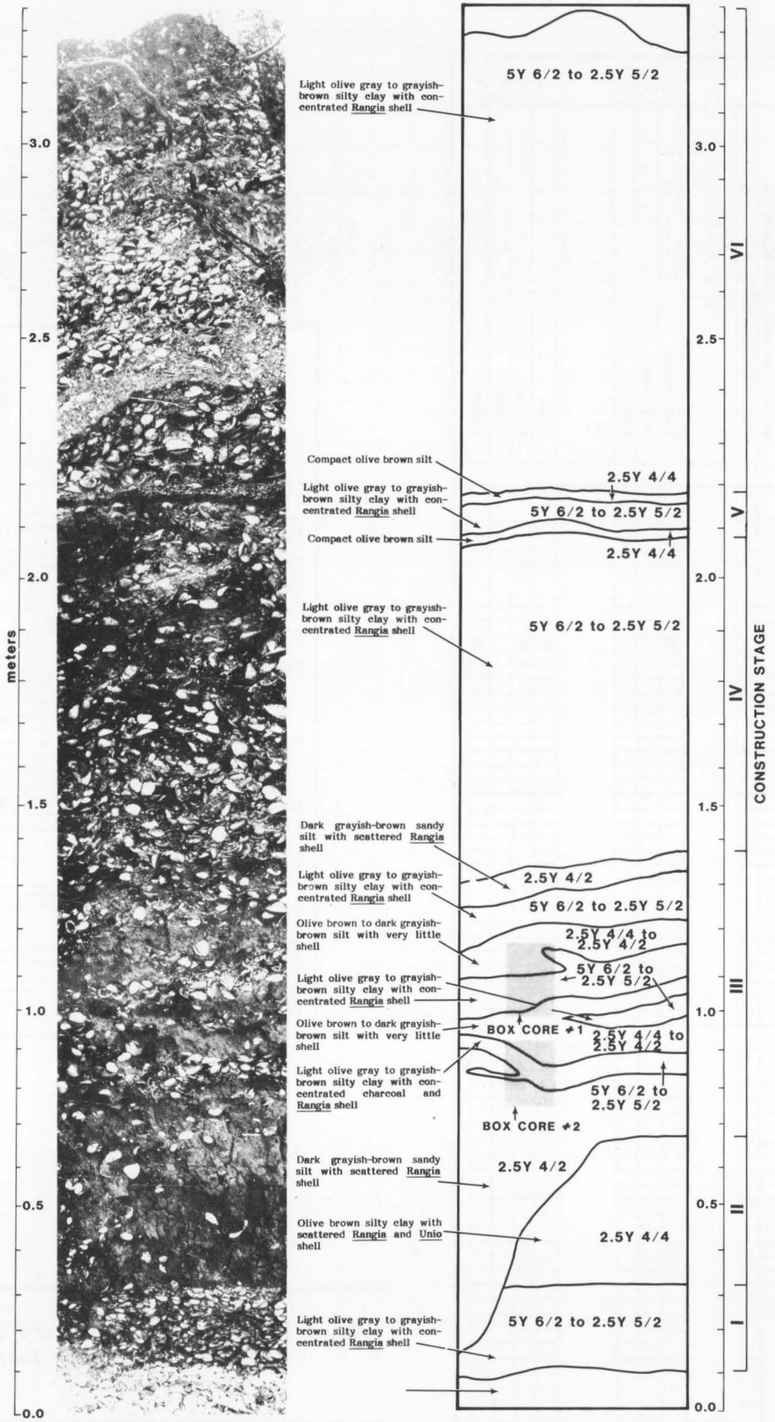

meters
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Light olive gray to grayish-brown silty clay with concentrated Rangia shell
5Y 6/2 to 2.5Y 5/2
Compact olive brown silt
2.5Y 4/4
Light olive gray to grayish-brown silty clay with concentrated Rangia shell
5Y 6/2 to 2.5Y 5/2
Compact olive brown silt
2.5Y 4/4
Light olive gray to grayish-brown silty clay with concentrated Rangia shell
5Y 6/2 to 2.5Y 5/2
Dark grayish-brown sandy silt with scattered Rangia shell
2.5Y 4/2
Light olive gray to grayish-brown silty clay with concentrated Rangia shell
5Y 6/2 to 2.5Y 5/2
Olive brown to dark grayish-brown silt with very little shell
2.5Y 4/4 to 2.5Y 4/2
Light olive gray to grayish-brown silty clay with concentrated Rangia shell
5Y 6/2 to 2.5Y 5/2
Olive brown to dark grayish-brown silt with very little shell
BOX CORE #1
2.5Y 4/4 to 2.5Y 4/2
Light olive gray to grayish-brown silty clay with concentrated charcoal and Rangia shell
5Y 6/2 to 2.5Y 5/2
BOX CORE #2
Dark grayish-brown sandy silt with scattered Rangia shell
2.5Y 4/2
Olive brown silty clay with scattered Rangia and Unio shell
2.5Y 4/4
Light olive gray to grayish-brown silty clay with concentrated Rangia shell
5Y 6/2 to 2.5Y 5/2
VI
V
IV
III
II
I
CONSTRUCTION STAGE

Figure 3-9A. Vertical section from The Temple site.

THE TEMPLE SITE (16 LF 4)

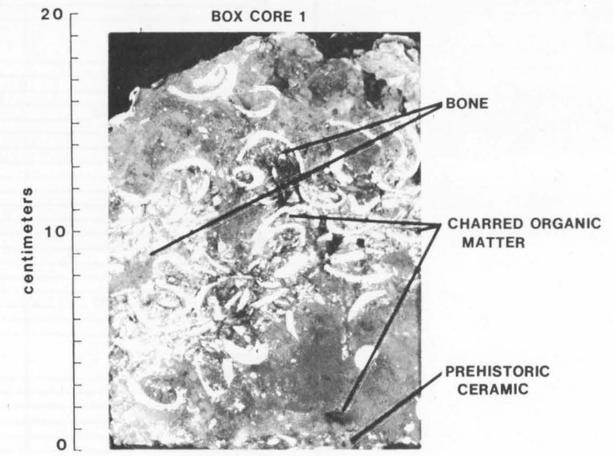


Figure 3-9B. Box core sample from The Temple site.

DESCRIPTORS

INDICATOR PARAMETERS	OCCURRENCE	% TOTAL: 1: 10 to 19%	2: 20 to 29%	3: 30 to 39%	4: 40 to 49%	5: 50 to 59%	6: 60 to 69%	7: 70 to 79%	8: 80 to 89%	9: 90 to 100%	SIZE (Wentworth Scale): Cobbles (-6 to -8 phi units) 64 to 256 mm	Pebbles (-2 to -6 phi units) 4 to 64 mm	Granules (-1 to -2 phi units) 2 to 4 mm	Very Coarse Sand (0 to -1 phi units) 1 to 2 mm	Coarse Sand (1 to 0 phi units) .5 to 1 mm	Medium Sand (2 to 1 phi units) .25 to .5 mm	Fine Sand (3 to 2 phi units) .125 to .25 mm	Very Fine Sand (4 to 3 phi units) .0625 to .125 mm	Silt (8 to 4 phi units) .00391 to .0625 mm	Clay (8 phi units) .00391 mm	SORTING: Poorly Sorted	Well Sorted	Uniform	PARTICLE CONDITION: Whole	Broken	Rounded	Angular
MAJOR CONSTITUENTS (80% or more)																											
CLASTIC SILICATES																											
Gravel																											
Sand																											
Silt	●			●																	●						
Clay																											
ORGANICS																											
Shell																											
Marine																											
Crassostrea																											
Rangia	●				●							●												●	●		●
Freshwater pelecypods																											
Other																											
Bone																											
Large mammals																											
Small mammals																											
Reptiles																											
Fish																											
Birds																											
Other																											
Plant																											
Wood																											
Leaves, twigs, etc.																											
Peat																											
Fibrous or grassy																											
Woody																											
Other																											
ARTIFACTS																											
Ceramics																											
Pottery																											
Fired Clay																											
Stone																											
Bone																											
Shell																											
Wood or Fiber																											
INCLUSIONS (20% or less)																											
Artifacts																											
Ceramics	●																										
Pottery																											
Fired Clay																											
Stone																											
Bone																											
Shell																											
Wood or Fiber																											
Shell																											
Marine																											
Crassostrea																											
Rangia	●											●												●	●		
Freshwater pelecypods																											
Other																											
Bone	●																										
Wood																											
Ash																											
Charcoal	●																										
Sediment Balls	S		●																								
Nodules																											
Calcareous																											
Silicious																											
Iron																											
Other																											

INDICATOR PARAMETERS	OCCURRENCE	
COLOR		
Description	Dark Gray Mottled Light Yellow Brown	
Munsell No.	2.5Y 4/0 2.5Y 6/4	
Homogenous		
Bedded	●	
Mottled		
Columnar		
BEDDING		
Thickness		
0-5 cm		
5-10 cm	●	
10-15 cm		
> 15 cm		
Contacts		
Sharp		
Burrowed		
Gradational	●	
Angular		
Horizontal		
Angular	●	
X-bedded		
Lenticular		
Distorted		
BIOTURBATION		
Large root molds		
Small root molds		
Rootlets		
Large animal burrows		
Small animal burrows		
Other		

S = SILT

Table 3-6. *Macro-sedimentary characteristics of box core 1 sample from The Temple site.*

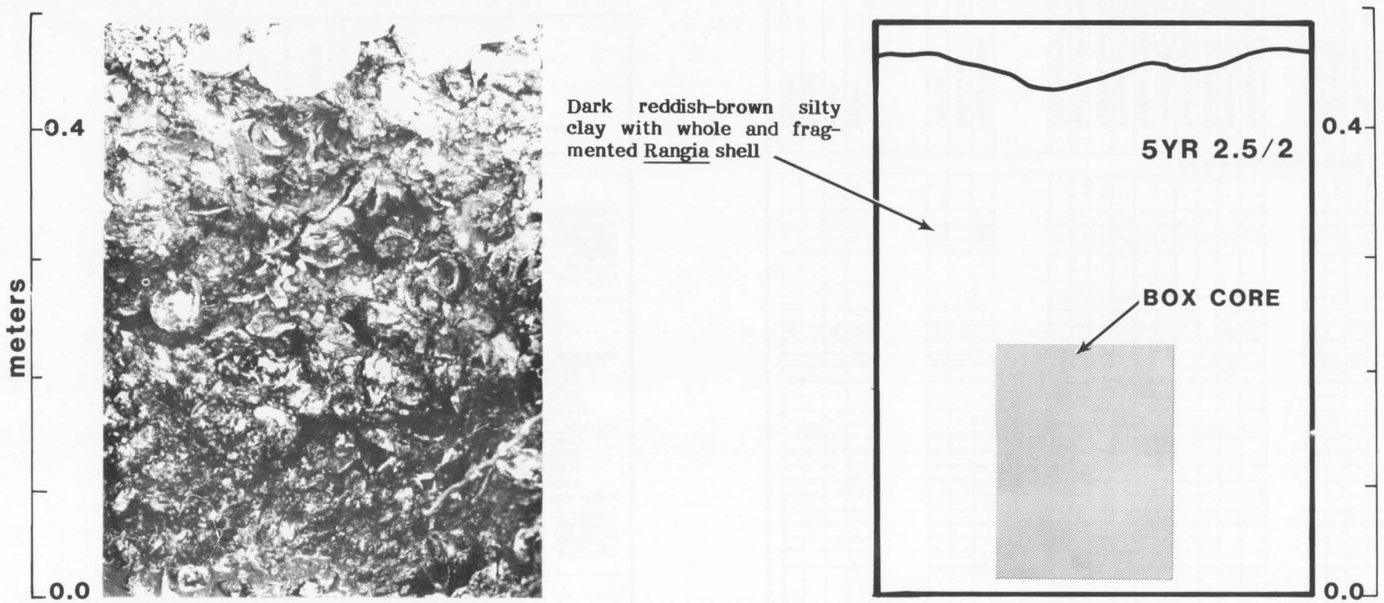


Figure 3-10A. Vertical section from the Bayou Cutler site.

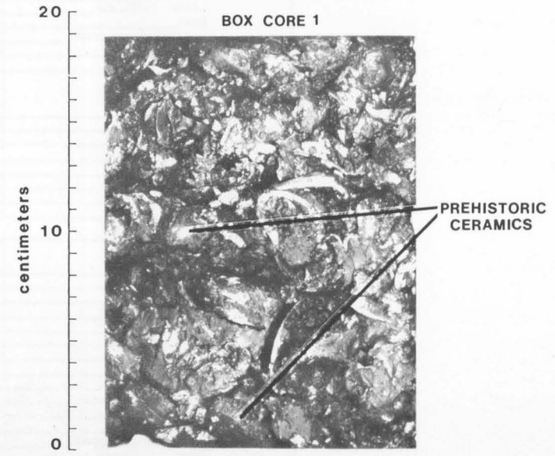


Figure 3-10B. Box core sample from the Bayou Cutler site.

DESCRIPTORS

INDICATOR PARAMETERS	OCCURRENCE	% TOTAL: 1: 10 to 19%	2: 20 to 29%	3: 30 to 39%	4: 40 to 49%	5: 50 to 59%	6: 60 to 69%	7: 70 to 79%	8: 80 to 89%	9: 90 to 100%	SIZE (Wentworth Scale): Cobbles (-6 to -8 phi units) 64 to 256 mm	Pebbles (-2 to -6 phi units) 4 to 64 mm	Granules (-1 to -2 phi units) 2 to 4 mm	Very Coarse Sand (0 to -1 phi units) 1 to 2 mm	Coarse Sand (1 to 0 phi units) .5 to 1 mm	Medium Sand (2 to 1 phi units) .25 to .5 mm	Fine Sand (3 to 2 phi units) .125 to .25 mm	Very Fine Sand (4 to 3 phi units) .0625 to .125 mm	Silt (8 to 4 phi units) .00391 to .0625 mm	Clay (8 phi units) .00391 mm	SORTING: Poorly Sorted	Well Sorted	Uniform	PARTICLE CONDITION: Whole	Broken	Rounded	Angular
MAJOR CONSTITUENTS (80% or more)																											
CLASTIC SILICATES																											
Gravel																											
Sand																											
Silt	●			●																	●						
Clay																											
ORGANICS																											
Shell																											
Marine																											
Crassostrea																											
Rangia	●						●					●									●			●	●		●
Freshwater pelecypods																											
Other																											
Bone																											
Large mammals																											
Small mammals																											
Reptiles																											
Fish																											
Birds																											
Other																											
Plant																											
Wood																											
Leaves, twigs, etc.																											
Peat																											
Fibrous or grassy																											
Woody																											
Other																											
ARTIFACTS																											
Ceramics																											
Pottery																											
Fired Clay																											
Stone																											
Bone																											
Shell																											
Wood or Fiber																											
INCLUSIONS (20% or less)																											
Artifacts																											
Ceramics																											
Pottery	●																										
Fired Clay																											
Stone																											
Bone																											
Shell																											
Wood or Fiber																											
Shell																											
Marine																											
Crassostrea																											
Rangia																											
Freshwater pelecypods																											
Other																											
Bone																											
Wood																											
Ash																											
Charcoal																											
Sediment Balls																											
Nodules																											
Calcareous																											
Silicious																											
Iron																											
Other																											

INDICATOR PARAMETERS	OCCURRENCE	
COLOR		
Description	Black	
Munsell No.	5YR 2/1	
Homogenous	●	
Bedded		
Mottled		
Columnar		
BEDDING		
Thickness		
0-5 cm		
5-10 cm		
10-15 cm		
>15 cm	●	
Contacts		
Sharp		
Burrowed		
Gradational		
Angular		
Horizontal	●	
Angular		
X-bedded		
Lenticular		
Distorted		
BIOTURBATION		
Large root molds		
Small root molds		
Rootlets		
Large animal burrows		
Small animal burrows		
Other		

Table 3-7. *Macro-sedimentary characteristics of box core 1 sample from the Bayou Cutler site.*

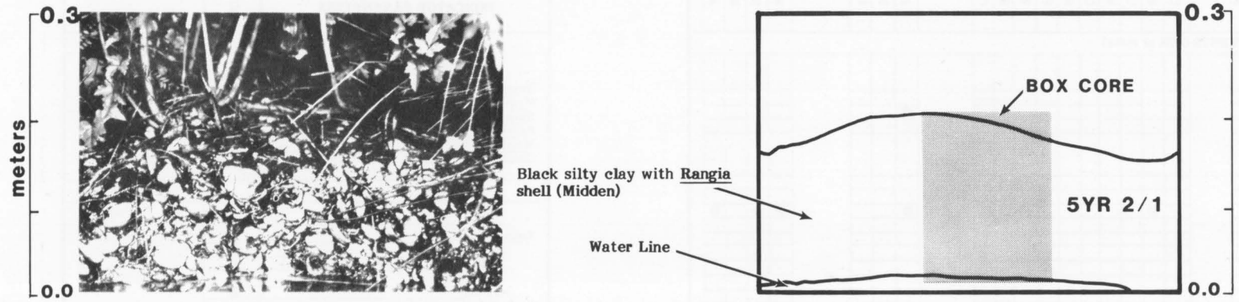


Figure 3-11A. *Vertical section from the Shotgun Shell site.*

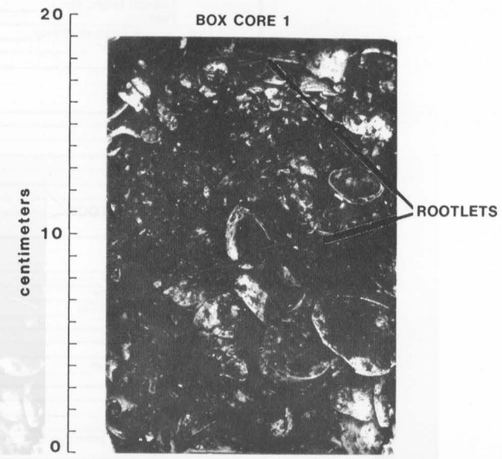


Figure 3-11B. *Box core sample from the Shotgun Shell site.*

DESCRIPTORS

INDICATOR PARAMETERS	OCCURRENCE	% TOTAL: 1: 10 to 19%	2: 20 to 29%	3: 30 to 39%	4: 40 to 49%	5: 50 to 59%	6: 60 to 69%	7: 70 to 79%	8: 80 to 89%	9: 90 to 100%	SIZE (Wentworth Scale): Cobbles (-6 to -8 phi units) 64 to 256 mm	Pebbles (-2 to -6 phi units) 4 to 64 mm	Granules (-1 to -2 phi units) 2 to 4 mm	Very Coarse Sand (0 to -1 phi units) 1 to 2 mm	Coarse Sand (1 to 0 phi units) .5 to 1 mm	Medium Sand (2 to 1 phi units) .25 to .5 mm	Fine Sand (3 to 2 phi units) .125 to .25 mm	Very Fine Sand (4 to 3 phi units) .0625 to .125 mm	Silt (8 to 4 phi units) .00391 to .0625 mm	Clay (8 phi units) .00391 mm	SORTING: Poorly Sorted	Well Sorted	Uniform	PARTICLE CONDITION: Whole	Broken	Rounded	Angular
MAJOR CONSTITUENTS (80% or more)																											
CLASTIC SILICATES																											
Gravel																											
Sand																											
Silt																											
Clay	●				●																●		●				
ORGANICS																											
Shell																											
Marine																											
Crassostrea																											
Rangia	●					●															●			●	●		●
Freshwater pelecypods																											
Other																											
Bone																											
Large mammals																											
Small mammals																											
Reptiles																											
Fish																											
Birds																											
Other																											
Plant																											
Wood																											
Leaves, twigs, etc.																											
Peat																											
Fibrous or grassy																											
Woody																											
Other																											
ARTIFACTS																											
Ceramics																											
Pottery																											
Fired Clay																											
Stone																											
Bone																											
Shell																											
Wood or Fiber																											
INCLUSIONS (20% or less)																											
Artifacts																											
Ceramics																											
Pottery																											
Fired Clay																											
Stone																											
Bone																											
Shell																											
Wood or Fiber																											
Shell																											
Marine																											
Crassostrea																											
Rangia																											
Freshwater pelecypods																											
Other																											
Bone																											
Wood																											
Ash																											
Charcoal																											
Sediment Balls																											
Nodules																											
Calcareous																											
Silicious																											
Iron																											
Other																											

INDICATOR PARAMETERS	OCCURRENCE	
COLOR		
Description	Black	
Munsell No.	5YR 2/1	
Homogenous	●	
Bedded		
Mottled		
Columnar		
BEDDING		
Thickness		
0-5 cm		
5-10 cm		
10-15 cm		
>15 cm	●	
Contacts		
Sharp		
Burrowed		
Gradational		
Angular		
Horizontal	●	
Angular		
X-bedded		
Lenticular		
Distorted		
BIOTURBATION		
Large root molds		
Small root molds	●	
Rootlets	●	
Large animal burrows		
Small animal burrows		
Other		

Table 3-8. *Macro-sedimentary characteristics of box core 1 sample from the Shotgun Shell site.*

JACKSON LANDING SITE
(22 HA 500)

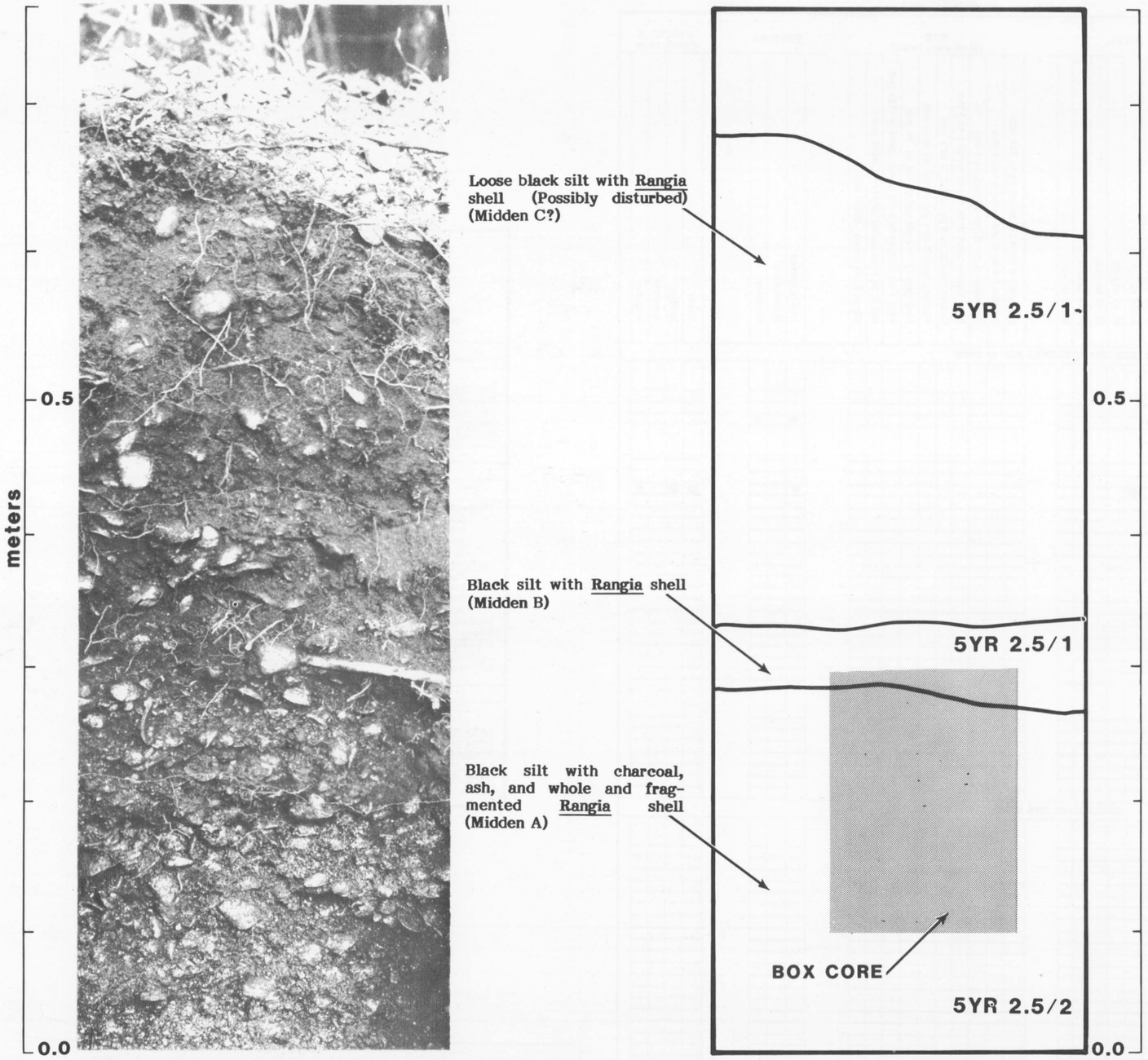


Figure 3-12A. Vertical section from the Jackson Landing site.

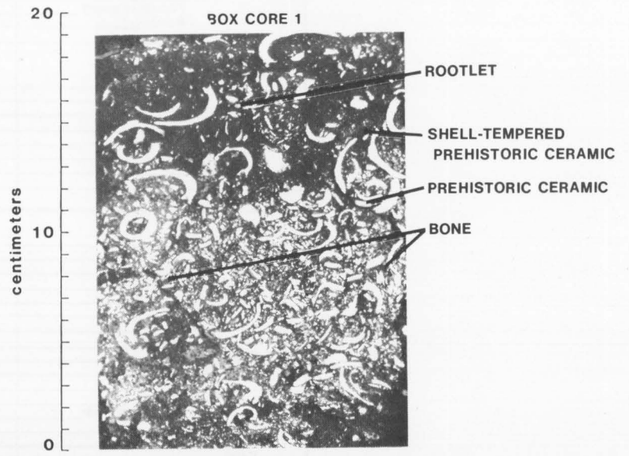


Figure 3-12B. Box core sample from the Jackson Landing site.

DESCRIPTORS

INDICATOR PARAMETERS	OCCURRENCE	% TOTAL: 1: 10 to 19%	2: 20 to 29%	3: 30 to 39%	4: 40 to 49%	5: 50 to 59%	6: 60 to 69%	7: 70 to 79%	8: 80 to 89%	9: 90 to 100%	SIZE (Wentworth Scale): Cobbles (-6 to -8 phi units) 64 to 256 mm	Pebbles (-2 to -6 phi units) 4 to 64 mm	Granules (-1 to -2 phi units) 2 to 4 mm	Very Coarse Sand (0 to -1 phi units) 1 to 2 mm	Coarse Sand (1 to 0 phi units) .5 to 1 mm	Medium Sand (2 to 1 phi units) .25 to .5 mm	Fine Sand (3 to 2 phi units) .125 to .25 mm	Very Fine Sand (4 to 3 phi units) .0625 to .125 mm	Silt (8 to 4 phi units) .00391 to .0625 mm	Clay (8 phi units) .00391 mm	SORTING: Poorly Sorted	Well Sorted	Uniform	PARTICLE CONDITION: Whole	Broken	Rounded	Angular
MAJOR CONSTITUENTS (80% or more)																											
CLASTIC SILICATES																											
Gravel																											
Sand																											
Silt																											
Clay	●			●																●	●						
ORGANICS																											
Shell																											
Marine																											
Crassostrea																											
Rangia	●							●				●												●	●		●
Freshwater pelecypods																											
Other																											
Bone																											
Large mammals																											
Small mammals																											
Reptiles																											
Fish																											
Birds																											
Other																											
Plant																											
Wood																											
Leaves, twigs, etc.																											
Peat																											
Fibrous or grassy																											
Woody																											
Other																											
ARTIFACTS																											
Ceramics																											
Pottery																											
Fired Clay																											
Stone																											
Bone																											
Shell																											
Wood or Fiber																											
INCLUSIONS (20% or less)																											
Artifacts																											
Ceramics																											
Pottery	●																										
Fired Clay																											
Stone																											
Bone																											
Shell																											
Wood or Fiber																											
Shell																											
Marine																											
Crassostrea																											
Rangia	●																							●	●		●
Freshwater pelecypods																											
Other																											
Bone	●																										
Wood																											
Ash																											
Charcoal																											
Sediment Balls																											
Nodules																											
Calcareous																											
Silicious																											
Iron																											
Other																											

INDICATOR PARAMETERS	OCCURRENCE	
COLOR		
Description	Very Dark Gray	
Munsell No.	10YR 3/1	
Homogenous	●	
Bedded		
Mottled		
Columnar		
BEDDING		
Thickness		
0-5 cm		
5-10 cm		
10-15 cm	●	
>15 cm		
Contacts		
Sharp		
Burrowed		
Gradational	●	
Angular		
Horizontal	●	
Angular		
X-bedded		
Lenticular		
Distorted		
BIOTURBATION		
Large root molds		
Small root molds	●	
Rootlets	●	
Large animal burrows		
Small animal burrows		
Other		

Table 3-9. *Macro-sedimentary characteristics of box core 1 sample from the Jackson Landing site.*

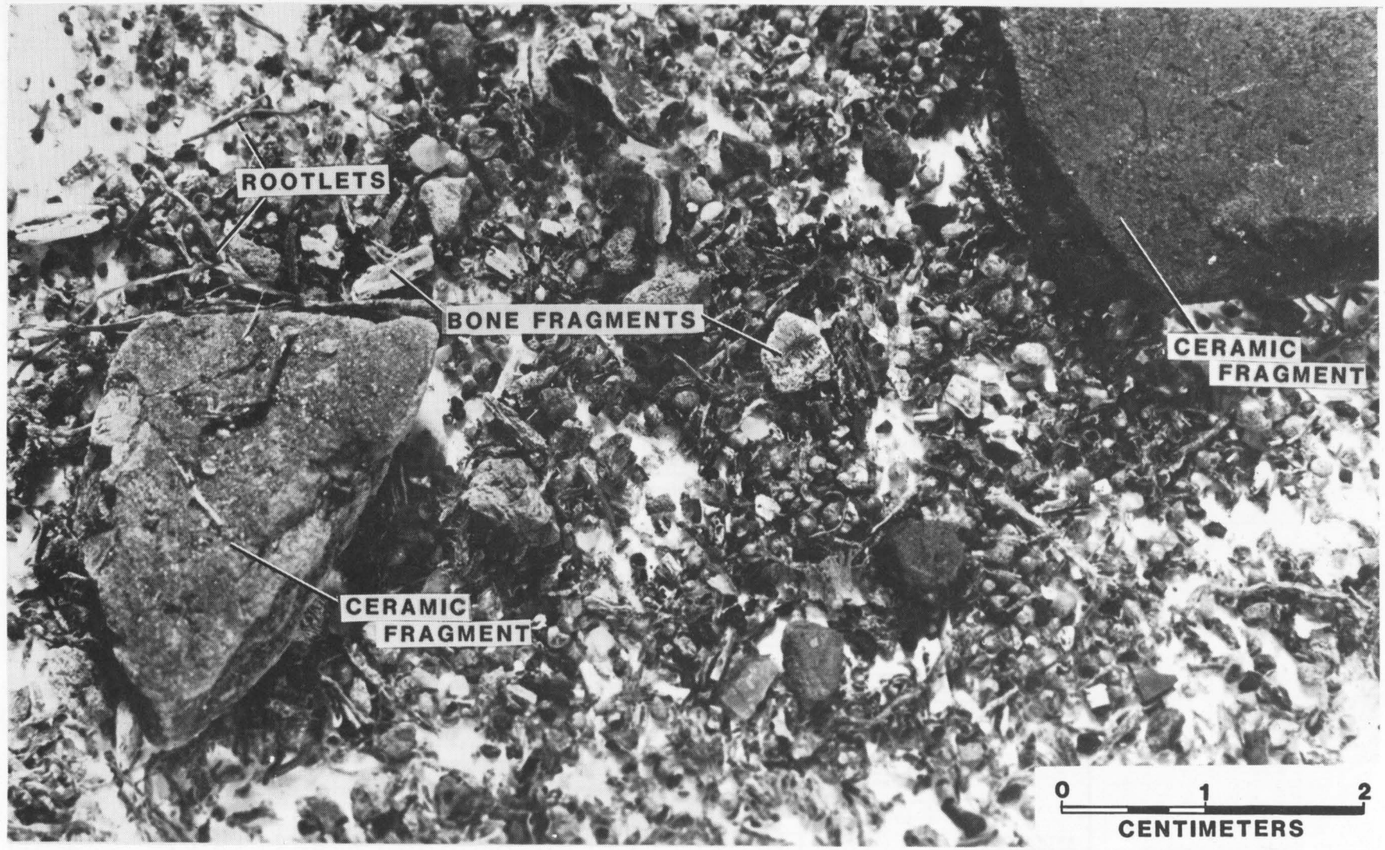


Figure 3-13. *Coarse fraction material from box core 1, Jeff Simmons site.*

CATEGORY C: SAND, SILT, OR SILTY CLAY WITH INCLUSIONS

(Figures 3-13 through 3-19; Tables 3-10 through 3-14)

The archaeological deposits sampled in four of the sites consisted of generally homogeneous, nonbedded, granular sediment with scattered inclusions of artifacts and/or ecofacts. This type of deposit would probably be the most difficult to identify if encountered in a core from the continental shelf, and yet may be relatively common from both coastal and inland sites. The homogenous character of the deposits can be attributed to several factors. All of these deposits have remained in a shallow, near-surface, subaerial situation and have been subjected to weathering and soil-forming processes during, and for a considerable period after, deposition. It is not surprising, then, that the most characteristic features are indications of often intensive subaerial weathering and bioturbation. The former is expressed as a humic stain of finely divided organic particles, iron nodules, and brown and tan oxidized colors. Indications of bioturbation include silt or clay balls, lack of distinctive bedding, root molds, and filled animal burrows.

Silt or clay balls may be simply displaced from underlying or neighboring deposits or introduced from another source. They may also exhibit effects of alteration, such as rolling or heating. Aten (1967) has reported an abundance of clay balls from the Jamison site, an earth midden occupied from the Late Archaic, through the Round Lake period of the Galveston Bay sequence (ca. 2000 B.C. to A.D. 1350). This site is located along the edge of the alluvial valley of the Trinity River near Dayton, Texas. Thirteen 5-ft-square excavations yielded approximately 1400 potsherds, 135 projectile points, 100 chipped stone artifacts, and 11,000 amorphous, hard clay objects. A sample of thirteen of the clay balls was selected for x-ray diffraction analysis of clay mineral phases. The specimens were selected on the basis of morphological variation and vertical and horizontal distribution within the midden. Diffraction patterns indicated that all of the specimens analyzed had been heated up to at least a temperature which had altered or destroyed the original clay minerals (approximately 500-600°C). It was concluded that there was a reasonable possibility that a very large proportion of the clay balls originated in close proximity to some domestic activity, such as a house or shelter, pottery manufacture, or fire hearth. Aten (1967:40) also noted that "Although clay balls have rarely been mentioned in the literature for southeast Texas, their presence is more or less common knowledge."

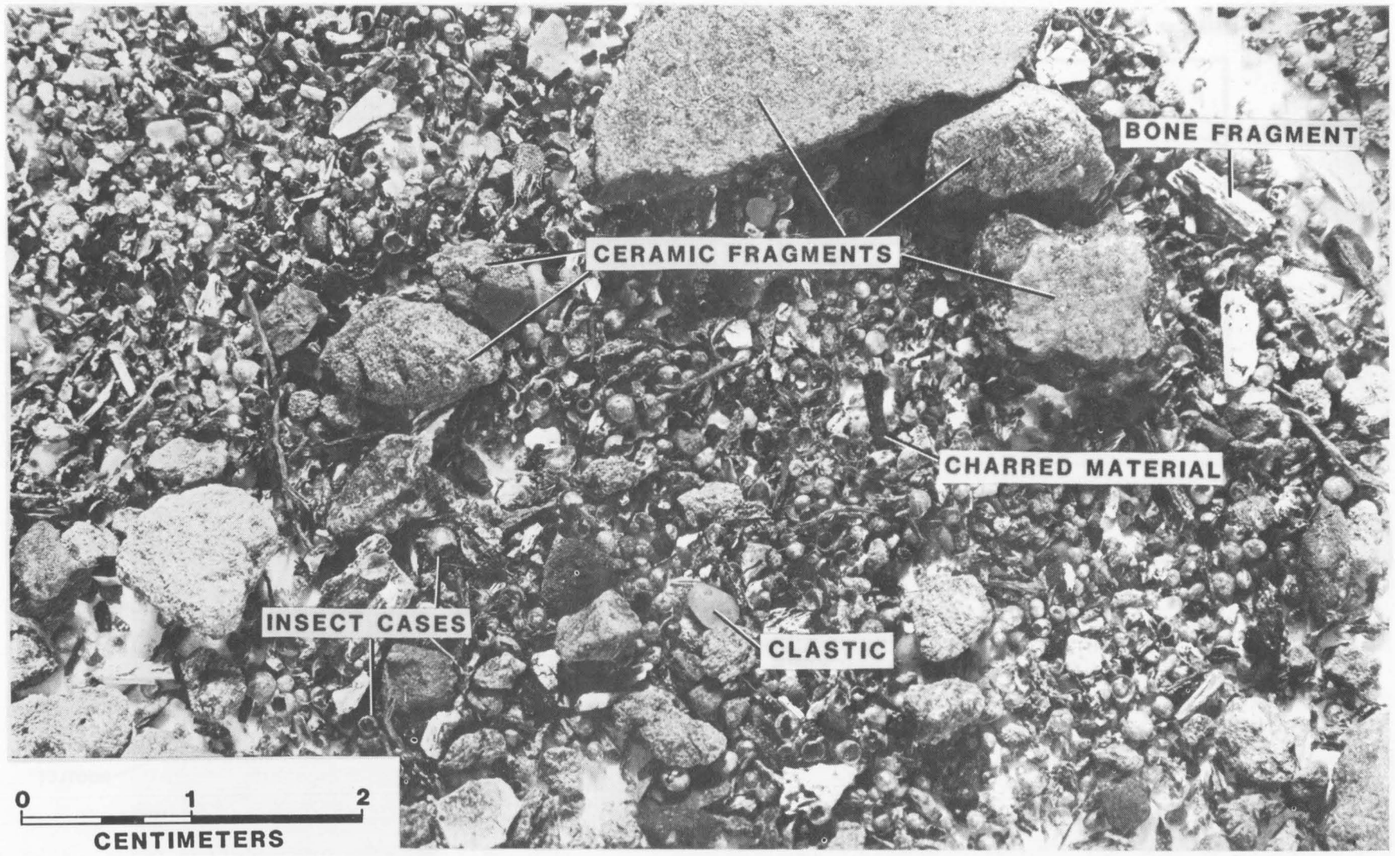


Figure 3-14. Coarse fraction material from box core 1, Smith Ridge site.

Distinctive inclusions occurred in all five of the samples. There is a tendency for the ecofacts to become chalky and show other indications of chemical weathering. Artifacts, however, are well represented and serve to identify these as archaeological deposits.

Archaeological deposits in this category could be confused with natural sedimentary deposits from a number of subaerial shore zone features. These include natural levee, point bar, beach, dune, and weathered Pleistocene surface. However, from the standpoint of identification of submerged sites, each of these natural features would be regarded as having a high probability for prehistoric site occurrence.

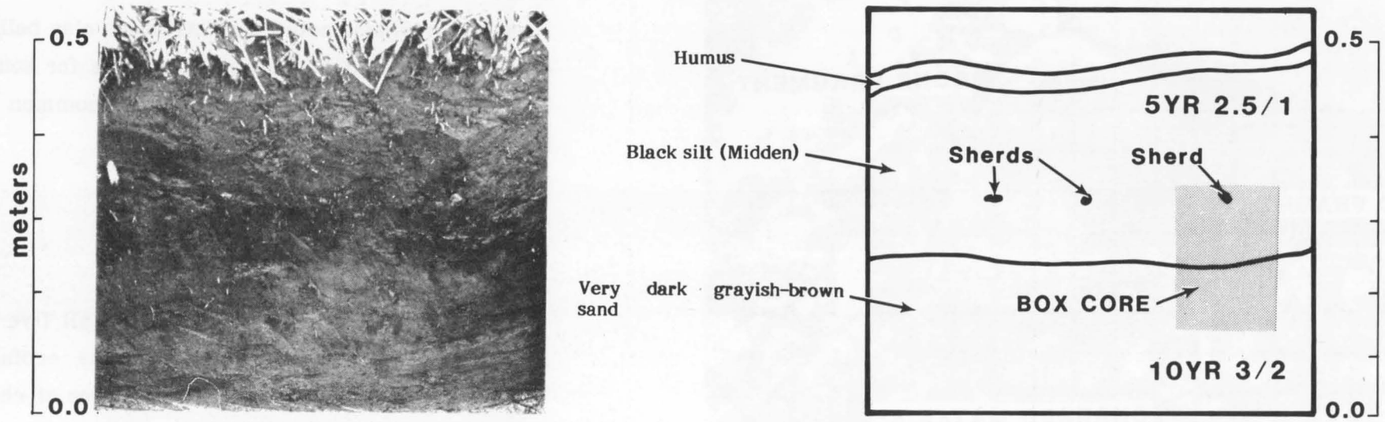


Figure 3-15A. Vertical section from the Smith Ridge site.

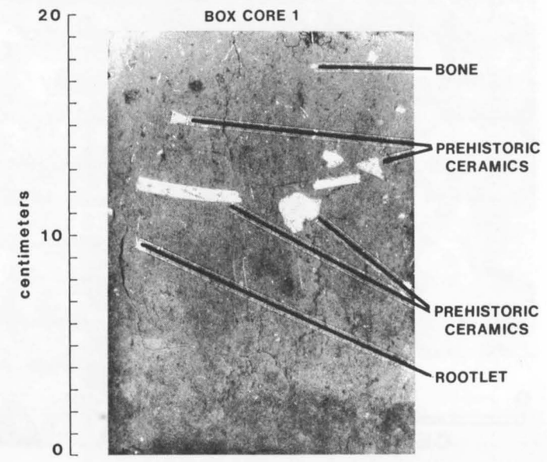


Figure 3-15B. Box core sample from the Smith Ridge site.

DESCRIPTORS

INDICATOR PARAMETERS	OCCURRENCE	% TOTAL: 1: 10 to 19%	2: 20 to 29%	3: 30 to 39%	4: 40 to 49%	5: 50 to 59%	6: 60 to 69%	7: 70 to 79%	8: 80 to 89%	9: 90 to 100%	SIZE (Wentworth Scale): Cobbles (-6 to -8 phi units) 64 to 256 mm	Pebbles (-2 to -6 phi units) 4 to 64 mm	Granules (-1 to -2 phi units) 2 to 4 mm	Very Coarse Sand (0 to -1 phi units) 1 to 2 mm	Coarse Sand (1 to 0 phi units) .5 to 1 mm	Medium Sand (2 to 1 phi units) .25 to .5 mm	Fine Sand (3 to 2 phi units) .125 to .25 mm	Very Fine Sand (4 to 3 phi units) .0625 to .125 mm	Silt (8 to 4 phi units) .00391 to .0625 mm	Clay (8 phi units) .00391 mm	SORTING: Poorly Sorted	Well Sorted	Uniform	PARTICLE CONDITION: Whole	Broken	Rounded	Angular
MAJOR CONSTITUENTS (80% or more)																											
CLASTIC SILICATES																											
Gravel																											
Sand																											
Silt	●									●									●			●					
Clay																											
ORGANICS																											
Shell																											
Marine																											
Crassostrea																											
Rangia																											
Freshwater pelecypods																											
Other																											
Bone																											
Large mammals																											
Small mammals																											
Reptiles																											
Fish																											
Birds																											
Other																											
Plant																											
Wood																											
Leaves, twigs, etc.																											
Peat																											
Fibrous or grassy																											
Woody																											
Other																											
ARTIFACTS																											
Ceramics																											
Pottery																											
Fired Clay																											
Stone																											
Bone																											
Shell																											
Wood or Fiber																											
INCLUSIONS (20% or less)																											
Artifacts																											
Ceramics																											
Pottery	●																										
Fired Clay																											
Stone																											
Bone	●																										
Shell																											
Wood or Fiber																											
Shell																											
Marine																											
Crassostrea																											
Rangia																											
Freshwater pelecypods																											
Other																											
Bone																											
Wood																											
Ash																											
Charcoal																											
Sediment Balls																											
Nodules																											
Calcareous																											
Silicious																											
Iron																											
Other																											

INDICATOR PARAMETERS	OCCURRENCE	
COLOR		
Description	Dark Gray	
Munsell No.	10YR 4/1	
Homogenous		
Bedded		
Mottled		
Columnar		
BEDDING		
Thickness		
0-5 cm		
5-10 cm		
10-15 cm		
>15 cm	●	
Contacts		
Sharp		
Burrowed		
Gradational		
Angular		
Horizontal		
Angular		
X-bedded		
Lenticular		
Distorted		
BIOTURBATION		
Large root molds		
Small root molds	●	
Rootlets	●	
Large animal burrows		
Small animal burrows		
Other		

Table 3-10. Macro-sedimentary characteristics of box 1 sample from the Smith Ridge site.

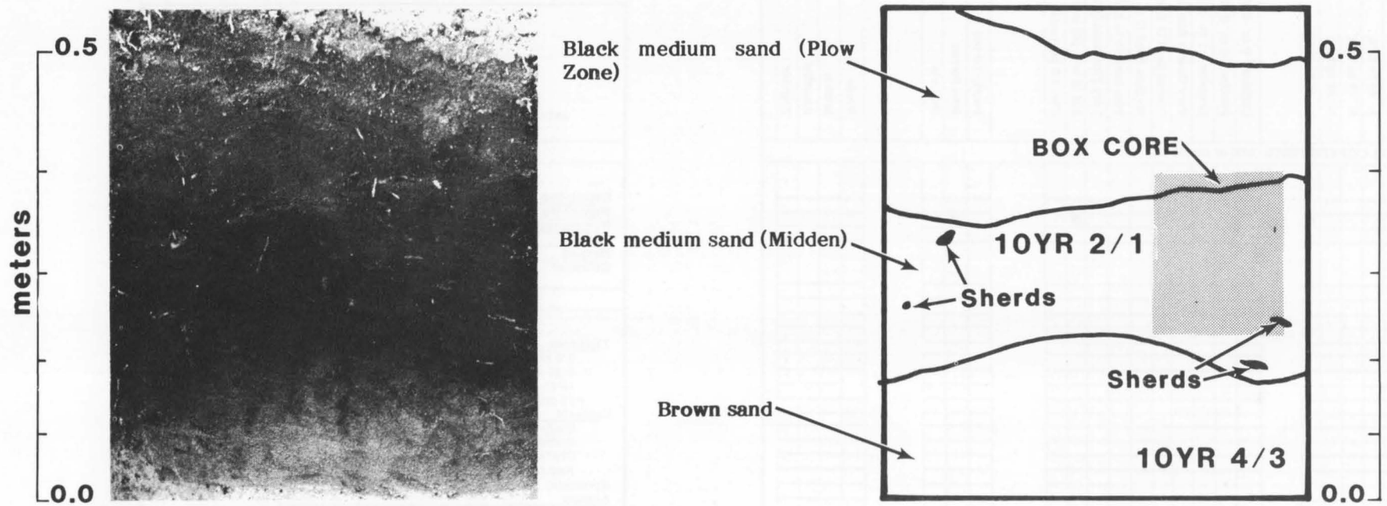


Figure 3-16A. Vertical section from the Jeff Simmons site.

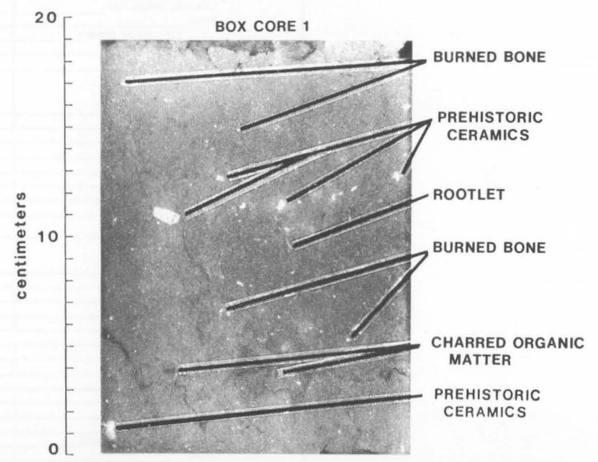


Figure 3-16B. Box core sample from the Jeff Simmons site.

DESCRIPTORS

INDICATOR PARAMETERS	OCCURRENCE	% TOTAL: 1: 10 to 19%	2: 20 to 29%	3: 30 to 39%	4: 40 to 49%	5: 50 to 59%	6: 60 to 69%	7: 70 to 79%	8: 80 to 89%	9: 90 to 100%	SIZE (Wentworth Scale): Cobbles (-6 to -8 phi units) 64 to 256 mm	Pebbles (-2 to -6 phi units) 4 to 64 mm	Granules (-1 to -2 phi units) 2 to 4 mm	Very Coarse Sand (0 to -1 phi units) 1 to 2 mm	Coarse Sand (1 to 0 phi units) .5 to 1 mm	Medium Sand (2 to 1 phi units) .25 to .5 mm	Fine Sand (3 to 2 phi units) .125 to .25 mm	Very Fine Sand (4 to 3 phi units) .0625 to .125 mm	Silt (8 to 4 phi units) .00391 to .0625 mm	Clay (8 phi units) .00391 mm	SORTING: Poorly Sorted	Well Sorted	Uniform	PARTICLE CONDITION: Whole	Broken	Rounded	Angular
MAJOR CONSTITUENTS (80% or more)																											
CLASTIC SILICATES																											
Gravel																											
Sand	●									●							●					●					
Silt																											
Clay																											
ORGANICS																											
Shell																											
Marine																											
Crassostrea																											
Rangia																											
Freshwater pelecypods																											
Other																											
Bone																											
Large mammals																											
Small mammals																											
Reptiles																											
Fish																											
Birds																											
Other																											
Plant																											
Wood																											
Leaves, twigs, etc.																											
Peat																											
Fibrous or grassy																											
Woody																											
Other																											
ARTIFACTS																											
Ceramics																											
Pottery																											
Fired Clay																											
Stone																											
Bone																											
Shell																											
Wood or Fiber																											
INCLUSIONS (20% or less)																											
Artifacts																											
Ceramics																											
Pottery	●																										
Fired Clay	●																										
Stone																											
Bone	C																										
Shell																											
Wood or Fiber																											
Shell																											
Marine																											
Crassostrea																											
Rangia																											
Freshwater pelecypods																											
Other																											
Bone																											
Wood																											
Ash																											
Charcoal	●																										
Sediment Balls																											
Nodules																											
Calcareous																											
Silicious																											
Iron																											
Other																											

INDICATOR PARAMETERS	OCCURRENCE
COLOR	
Description	Dark Gray
Munsell No.	10YR 4/1
Homogenous	
Bedded	
Mottled	
Columnar	
BEDDING	
Thickness	
0-5 cm	
5-10 cm	
10-15 cm	
>15 cm	●
Contacts	
Sharp	
Burrowed	
Gradational	
Angular	
Horizontal	
Angular	
X-bedded	
Lenticular	
Distorted	
BIOTURBATION	
Large root molds	
Small root molds	●
Rootlets	
Large animal burrows	
Small animal burrows	
Other	

C = CHARRED

Table 3-11. Macro-sedimentary characteristics of box core 1 sample from the Jeff Simmons site.

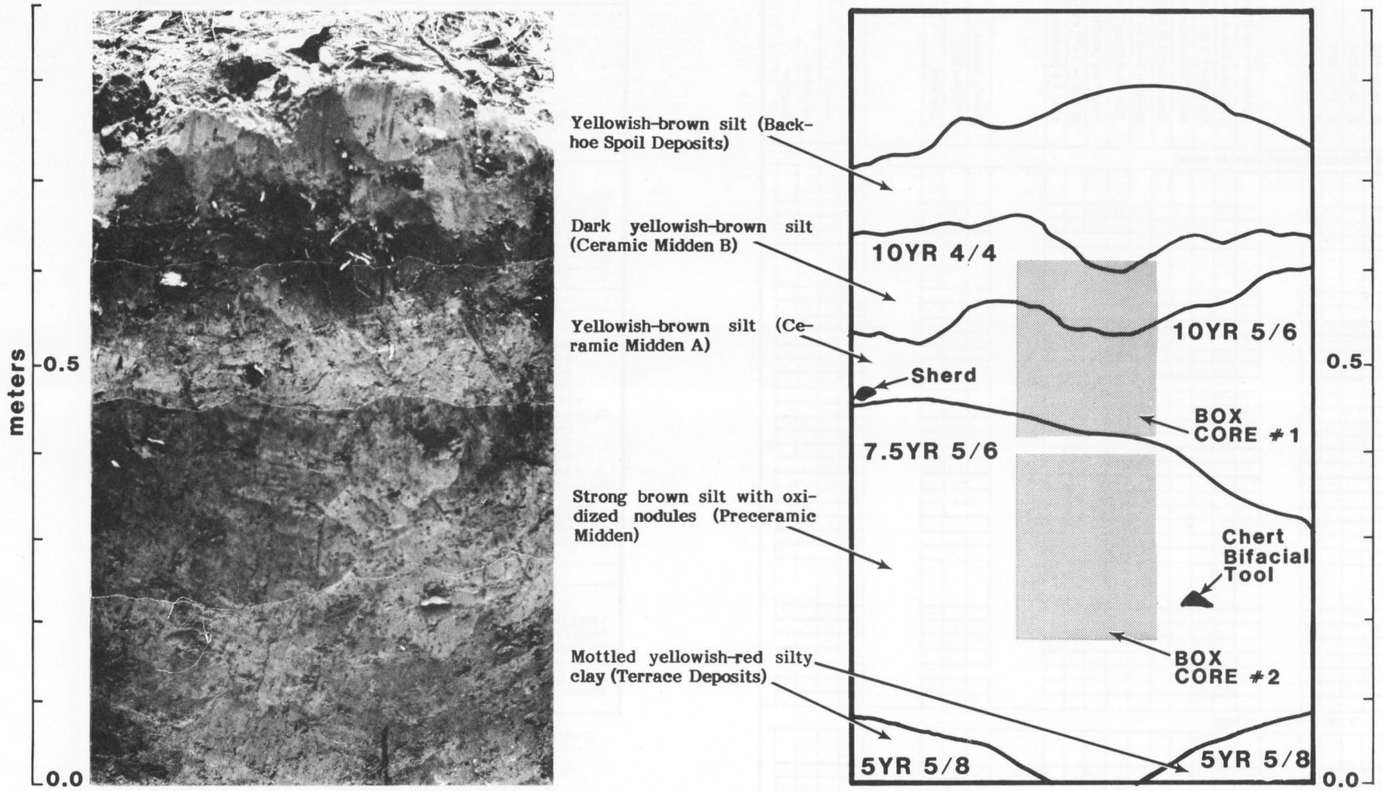


Figure 3-17A. Vertical section from the Bayou Blue site.

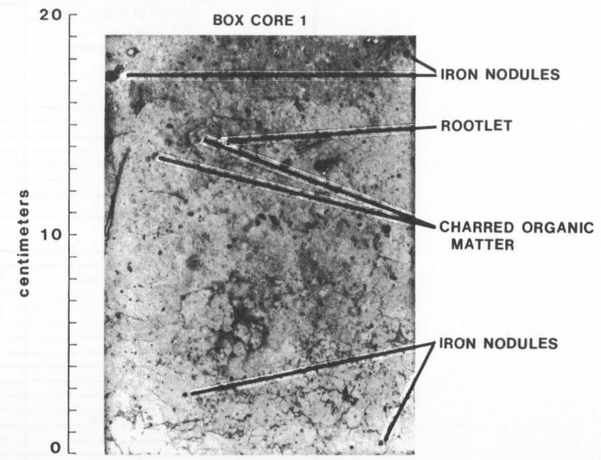


Figure 3-17B. Box core sample from the Bayou Blue site.

DESCRIPTORS

INDICATOR PARAMETERS	OCCURRENCE	% TOTAL: 1: 10 to 19%	2: 20 to 29%	3: 30 to 39%	4: 40 to 49%	5: 50 to 59%	6: 60 to 69%	7: 70 to 79%	8: 80 to 89%	9: 90 to 100%	SIZE (Wentworth Scale): Cobbles (-6 to -8 phi units) 64 to 256 mm	Pebbles (-2 to -6 phi units) 4 to 64 mm	Granules (-1 to -2 phi units) 2 to 4 mm	Very Coarse Sand (0 to -1 phi units) 1 to 2 mm	Coarse Sand (1 to 0 phi units) .5 to 1 mm	Medium Sand (2 to 1 phi units) .25 to .5 mm	Fine Sand (3 to 2 phi units) .125 to .25 mm	Very Fine Sand (4 to 3 phi units) .0625 to .125 mm	Silt (8 to 4 phi units) .00391 to .0625 mm	Clay (8 phi units) .00391 mm	SORTING: Poorly Sorted	Well Sorted	Uniform	PARTICLE CONDITION: Whole	Broken	Rounded	Angular
MAJOR CONSTITUENTS (80% or more)																											
CLASTIC SILICATES																											
Gravel																											
Sand																											
Silt	●				●														●			●					
Clay	●			●																●		●					
ORGANICS																											
Shell																											
Marine																											
Crassostrea																											
Rangia																											
Freshwater pelecypods																											
Other																											
Bone																											
Large mammals																											
Small mammals																											
Reptiles																											
Fish																											
Birds																											
Other																											
Plant																											
Wood																											
Leaves, twigs, etc.																											
Peat																											
Fibrous or grassy																											
Woody																											
Other																											
ARTIFACTS																											
Ceramics																											
Pottery																											
Fired Clay																											
Stone																											
Bone																											
Shell																											
Wood or Fiber																											
INCLUSIONS (20% or less)																											
Artifacts																											
Ceramics																											
Pottery	●																										
Fired Clay	●																										
Stone	●																										
Bone																											
Shell																											
Wood or Fiber																											
Shell																											
Marine																											
Crassostrea																											
Rangia																											
Freshwater pelecypods																											
Other																											
Bone																											
Wood																											
Ash																											
Charcoal	●																										
Sediment Balls	S				●						●										●						●
Nodules																											
Calcareous																											
Silicious																											
Iron	●													●	●												
Other																											

INDICATOR PARAMETERS	OCCURRENCE	
COLOR		
Description	Gray to Very Pale Brown	
Munsell No.	10YR 6/1 to 10YR 7/3	
Homogenous		
Bedded	●	
Mottled	●	
Columnar		
BEDDING		
Thickness		
0-5 cm		
5-10 cm		
10-15 cm	●	
>15 cm		
Contacts		
Sharp		
Burrowed		
Gradational	●	
Angular		
Horizontal	●	
Angular		
X-bedded		
Lenticular		
Distorted	●	
BIOTURBATION		
Large root molds		
Small root molds	●	
Rootlets	●	
Large animal burrows		
Small animal burrows	●	
Other		

S = SILT BALLS

Table 3-12. Macro-sedimentary characteristics of box core 1 sample from the Bayou Blue site.

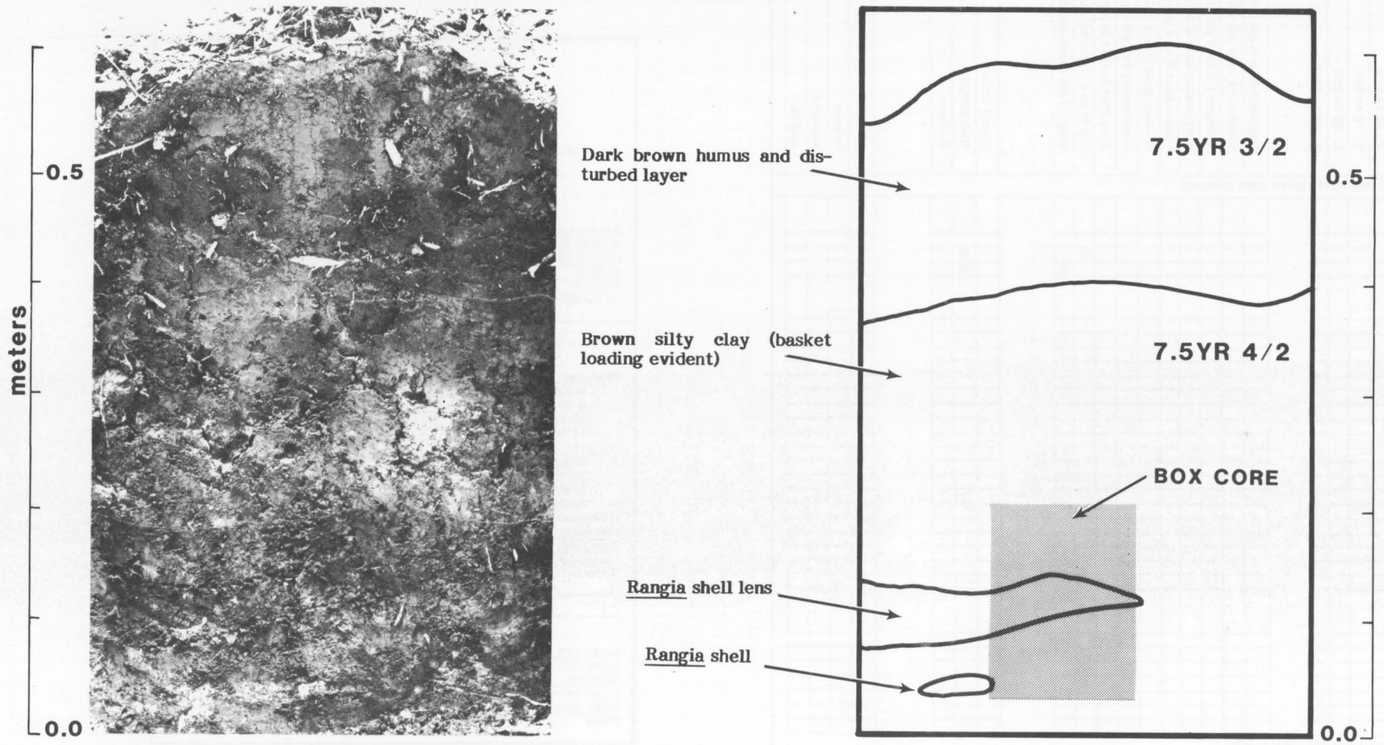


Figure 3-18A. Vertical section from the Magnolia Mound site.

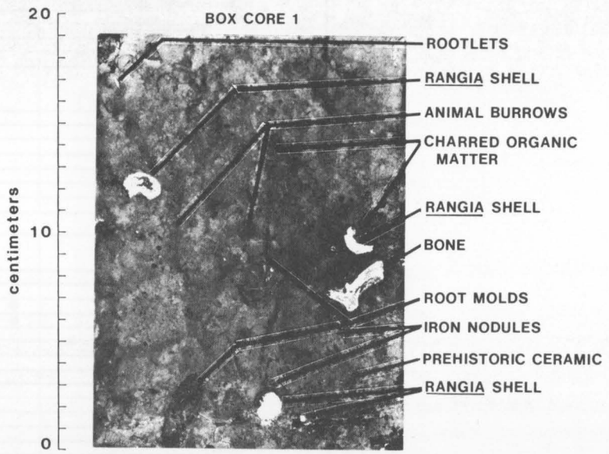


Figure 3-18B. Box core sample from the Magnolia Mound site.

DESCRIPTORS

INDICATOR PARAMETERS	OCCURRENCE	% TOTAL: 1: 10 to 19%	2: 20 to 29%	3: 30 to 39%	4: 40 to 49%	5: 50 to 59%	6: 60 to 69%	7: 70 to 79%	8: 80 to 89%	9: 90 to 100%	SIZE (Wentworth Scale): Cobbles (-6 to -8 phi units) 64 to 256 mm	Pebbles (-2 to -6 phi units) 4 to 64 mm	Granules (-1 to -2 phi units) 2 to 4 mm	Very Coarse Sand (0 to -1 phi units) 1 to 2 mm	Coarse Sand (1 to 0 phi units) .5 to 1 mm	Medium Sand (2 to 1 phi units) .25 to .5 mm	Fine Sand (3 to 2 phi units) .125 to .25 mm	Very Fine Sand (4 to 3 phi units) .0625 to .125 mm	Silt (8 to 4 phi units) .00391 to .0625 mm	Clay (8 phi units) .00391 mm	SORTING: Poorly Sorted	Well Sorted	Uniform	PARTICLE CONDITION: Whole	Broken	Rounded	Angular
MAJOR CONSTITUENTS (80% or more)																											
CLASTIC SILICATES																											
Gravel																											
Sand																											
Silt	●									●									●			●	●				
Clay																											
ORGANICS																											
Shell																											
Marine																											
Crassostrea																											
Rangia																											
Freshwater pelecypods																											
Other																											
Bone																											
Large mammals																											
Small mammals																											
Reptiles																											
Fish																											
Birds																											
Other																											
Plant																											
Wood																											
Leaves, twigs, etc.																											
Peat																											
Fibrous or grassy																											
Woody																											
Other																											
ARTIFACTS																											
Ceramics																											
Pottery																											
Fired Clay																											
Stone																											
Bone																											
Shell																											
Wood or Fiber																											
INCLUSIONS (20% or less)																											
Artifacts																											
Ceramics																											
Pottery	●																										
Fired Clay																											
Stone																											
Bone																											
Shell																											
Wood or Fiber																											
Shell																											
Marine																											
Crassostrea																											
Rangia	●																										
Freshwater pelecypods																											
Other																											
Bone	●																										
Wood																											
Ash																											
Charcoal	●																										
Sediment Balls																											
Nodules																											
Calcareous																											
Silicious																											
Iron	●																										
Other																											

INDICATOR PARAMETERS	OCCURRENCE	
COLOR		
Description	Pale Brown to Very Pale Brown	
Munsell No.	10YR 6/3 to 10YR 7/3	
Homogenous		
Bedded		
Mottled	●	
Columnar		
BEDDING		
Thickness		
0-5 cm		
5-10 cm		
10-15 cm		
> 15 cm	●	
Contacts		
Sharp		
Burrowed		
Gradational		
Angular		
Horizontal		
Angular		
X-bedded		
Lenticular		
Distorted		
BIOTURBATION		
Large root molds	●	
Small root molds	●	
Rootlets		
Large animal burrows		
Small animal burrows	●	
Other		

Table 3-13. *Macro-sedimentary characteristics of box core 1 sample from the Magnolia Mound site.*

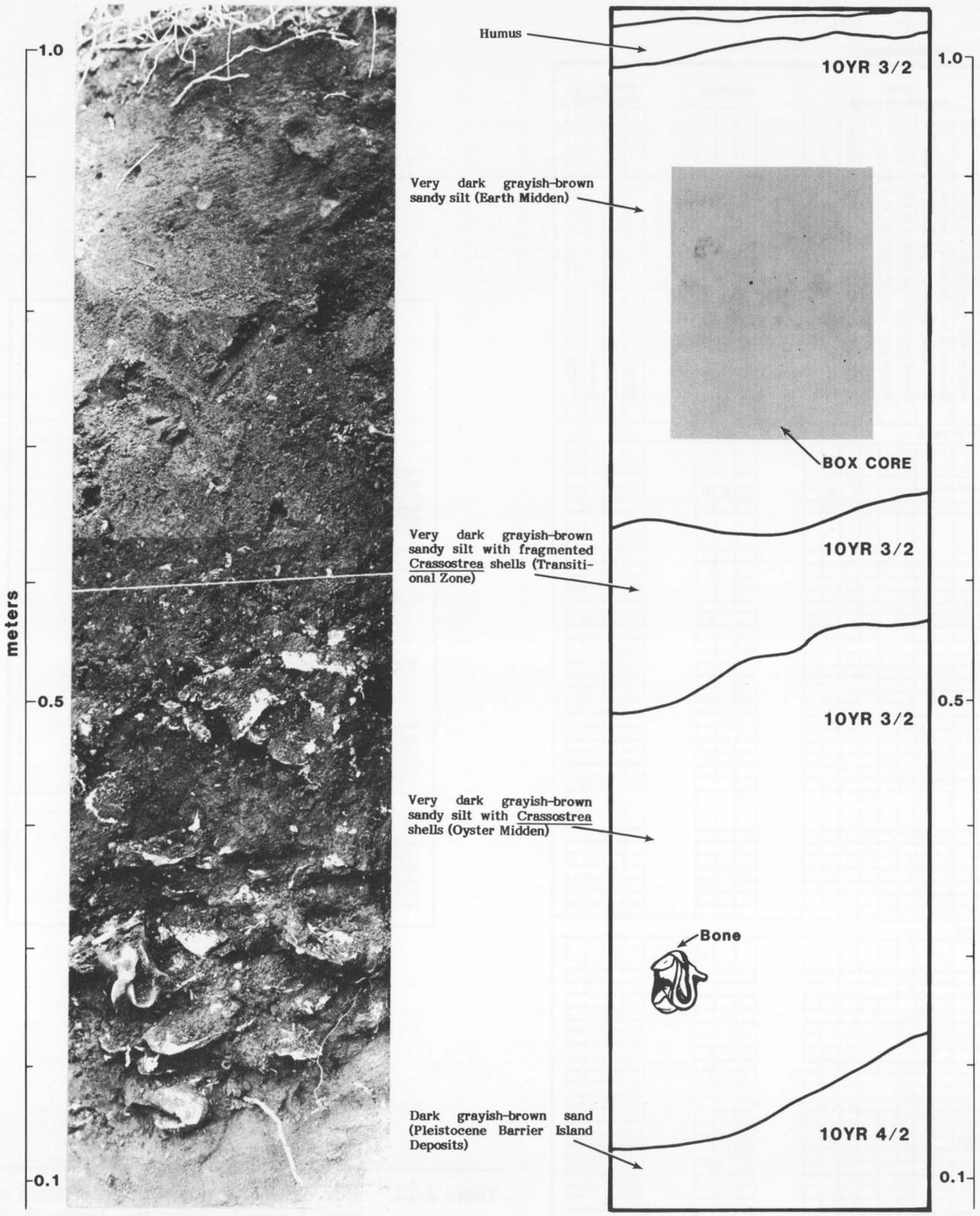


Figure 3-19A. *Vertical section from the Cedarland site.*

CEDARLAND SITE (22 HA 506)

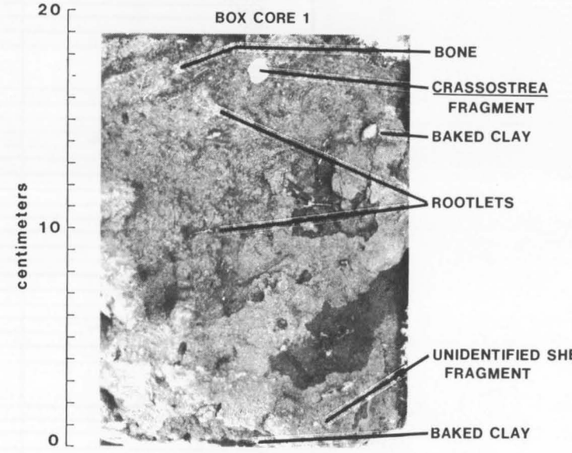


Figure 3-19B. *Box core sample from the Cedarland site.*

DESCRIPTORS

INDICATOR PARAMETERS	OCCURRENCE	% TOTAL: 1: 10 to 19%	2: 20 to 29%	3: 30 to 39%	4: 40 to 49%	5: 50 to 59%	6: 60 to 69%	7: 70 to 79%	8: 80 to 89%	9: 90 to 100%	SIZE (Wentworth Scale): Cobbles (-6 to -8 phi units) 64 to 256 mm	Pebbles (-2 to -6 phi units) 4 to 64 mm	Granules (-1 to -2 phi units) 2 to 4 mm	Very Coarse Sand (0 to -1 phi units) 1 to 2 mm	Coarse Sand (1 to 0 phi units) .5 to 1 mm	Medium Sand (2 to 1 phi units) .25 to .5 mm	Fine Sand (3 to 2 phi units) .125 to .25 mm	Very Fine Sand (4 to 3 phi units) .0625 to .125 mm	Silt (8 to 4 phi units) .00391 to .0625 mm	Clay (8 phi units) .00391 mm	SORTING: Poorly Sorted	Well Sorted	Uniform	PARTICLE CONDITION: Whole	Broken	Rounded	Angular
MAJOR CONSTITUENTS (80% or more)																											
CLASTIC SILICATES																											
Gravel																											
Sand	●									●						●						●	●				
Silt																											
Clay																											
ORGANICS																											
Shell																											
Marine																											
Crassostrea																											
Rangia																											
Freshwater pelecypods																											
Other																											
Bone																											
Large mammals																											
Small mammals																											
Reptiles																											
Fish																											
Birds																											
Other																											
Plant																											
Wood																											
Leaves, twigs, etc.																											
Peat																											
Fibrous or grassy																											
Woody																											
Other																											
ARTIFACTS																											
Ceramics																											
Pottery																											
Fired Clay																											
Stone																											
Bone																											
Shell																											
Wood or Fiber																											
INCLUSIONS (20% or less)																											
Artifacts																											
Ceramics																											
Pottery																											
Fired Clay	●										●													●			
Stone																											
Bone																											
Shell																											
Wood or Fiber																											
Shell																											
Marine																											
Crassostrea	●										●													●			
Rangia																											
Freshwater pelecypods																											
Other																											
Bone	●										●													●			
Wood																											
Ash																											
Charcoal																											
Sediment Balls																											
Nodules																											
Calcareous																											
Silicious																											
Iron																											
Other																											

INDICATOR PARAMETERS	OCCURRENCE
COLOR	
Description	Brown
Munsell No.	10YR 4/3
Homogenous	
Bedded	
Mottled	●
Columnar	
BEDDING	
Thickness	
0-5 cm	
5-10 cm	
10-15 cm	
> 15 cm	●
Contacts	
Sharp	
Burrowed	
Gradational	
Angular	
Horizontal	
Angular	
X-bedded	
Lenticular	
Distorted	
BIOTURBATION	
Large root molds	●
Small root molds	●
Rootlets	●
Large animal burrows	
Small animal burrows	
Other	

Table 3-14. *Macro-sedimentary characteristics of box core from the upper level of the Cedarland site.*

CATEGORY D: BONE BEDS

(Figures 3-20 through 3-21; Table 3-15)

Beds composed of a high percentage of bone are relatively rare both geologically and archaeologically. Bone with very little detrital clastic matrix has been found at the Lower Vacherie site (16 SJ 2) and was sampled for the present study. At this site, the bone deposits are interbedded with natural levee silts and clays, Rangia shell, Unio shell, and other midden deposits (Figure 3-21). The bone is largely that of fish, with some deer, muskrat, and other small mammals and reptiles. Perishable plant materials also have been recovered from the deposits. These include wood, seeds, gourds, and cordage. Fragments of charcoal, small pieces of shell, and potsherds occur as inclusions within the bone.

Bone beds require special conditions for both accumulation and preservation. At the Lower Vacherie site, they are probably associated with food processing, involving preparation and cooking of fish and game. The bone accumulated rapidly, probably in standing water adjacent to the site (in a swamp or along the edge of a sluggish stream). Most coastal sites probably were adjacent to, or surrounded by, shallow water bodies or wetlands which provided convenient disposal sites for "ripe" garbage. In addition to rapid accumulation under standing water conditions, the bone at Lower Vacherie also was rapidly buried by other midden deposits and by clastic detrital sediment (natural levee) introduced through the active river crevasse with which the site was associated. Thus, the bone beds became incorporated into the sedimentary sequence of the crevasse system.

Similar bone beds have been observed at the Miller site (16 SM 6) on Belle River in St. Martin Parish, Louisiana. Like Lower Vacherie, the Miller site is situated in the upper, freshwater end of an interdistributary estuarine basin in the Mississippi deltaic plain. The site was inhabited principally during the Baytown and Coles Creek periods (ca. A.D. 400 to A.D. 1000). The stratigraphy was similar to that at Lower Vacherie, consisting of beds of bone, Rangia shell, and Unio shell. The bone beds were observed in a dragline pit dug for shell to be used as road metal. These beds consisted of lenses of small fish and animal bone, 10 to 20 cm or more in thickness and 4 to 5 m in diameter.

Still another site with beds of small animal bone is the Linsley site (16 OR 40), located in Orleans Parish, Louisiana (Gagliano and Saucier 1963). This Poverty Point period site is believed to have been located on a distributary within an active subdelta along the lower reaches of the Mississippi River. The bone beds here were observed in dragline spoil lumps. Most of the beds were relatively thin (10 cm) and were interbedded with natural levee silts and clays and Rangia shell layers. Bones were predominately of small mammals and birds with some fish, reptiles, and deer.

Bone inclusions within a shell or sand matrix are much more common than bone beds in coastal middens. In such situations the bone usually makes up less than 10% of the total volume and may be associated with other inclusions such as shell, charcoal, or artifacts.

Natural bone beds do occur in the geological record, though they are not extremely common. Their rarity is related to the requirement of unusual natural situations which combine bone preservation and accumulation. The two most frequent situations are deposits in wet depressions (watering holes, springs, bogs, tar pits) and reworked deposits of bone lag (phosphate beds).

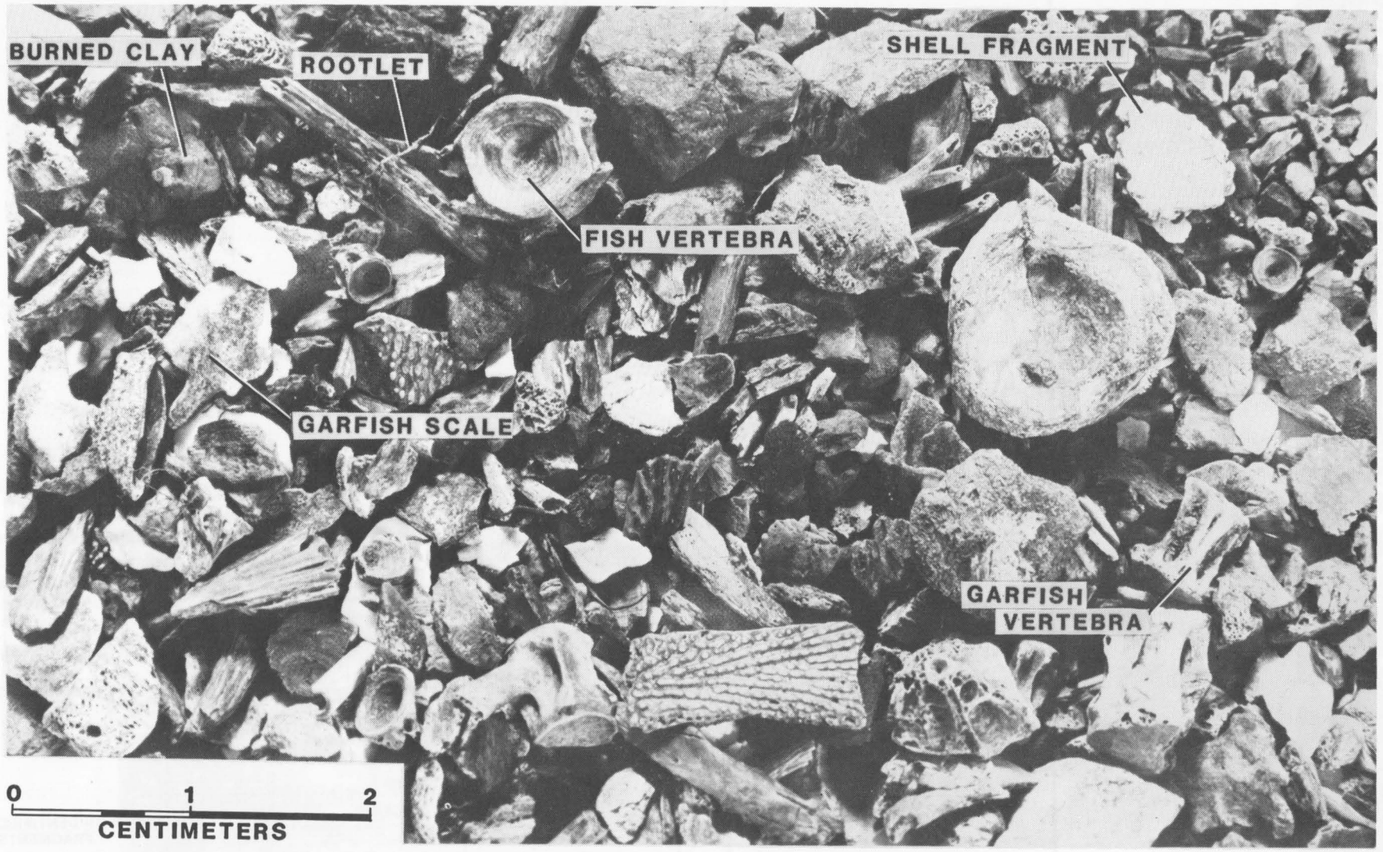


Figure 3-20. *Coarse fraction material from the bone bed of the Lower Vacherie site.*

Depression deposits may accumulate in sinkholes (karst regions or on salt domes), depressions on coastal terraces (bay galls, channel remnants), or in dune lakes. These are usually places to which animals were attracted and subsequently became trapped and died. In addition to remains of the primary entrapped animals, there are usually bones of predators and scavangers. In contrast to cultural bone beds, deposition rates in natural beds are typically low, and there is usually standing water which enhances preservation. Natural deposits frequently contain partially articulated skeletal remains.

Bone may accumulate as a lag deposit above an erosional surface or along the swash line of beaches. The Pliocene phosphate beds of the Florida highlands provide an excellent example of the former situation. Beach swash deposits tend to be more localized and are more common. In these settings, reworked bones are usually heavily mineralized, rounded, and abraded. They may exhibit evidence of boring and encrustation by marine organisms. There is usually an abundance of teeth, and there may be a great admixture of terrestrial and marine fossils.

A number of late Pleistocene natural bone beds have been found to contain human skeletal remains or cultural material. An example of one of these situations is the Vero Beach site in Florida (Weigel 1962). At these sites, the relative influence or impact of human activity on the bone deposits generally is presumed to be minimal. The occurrence of human artifacts in natural deposits does indicate that difficulties are likely to arise in distinguishing between natural and cultural bone deposits. This is especially true when small samples serve as the basis for identification. Presumably such things as the species composition of the faunal assemblage and the skeletal elements represented will serve to distinguish between natural and cultural deposits when obvious evidence (artifacts) of human activity is absent. The accumulation of data from archaeological bone deposits will eventually establish the criteria needed for making identification in these overlap situations.

CATEGORY D

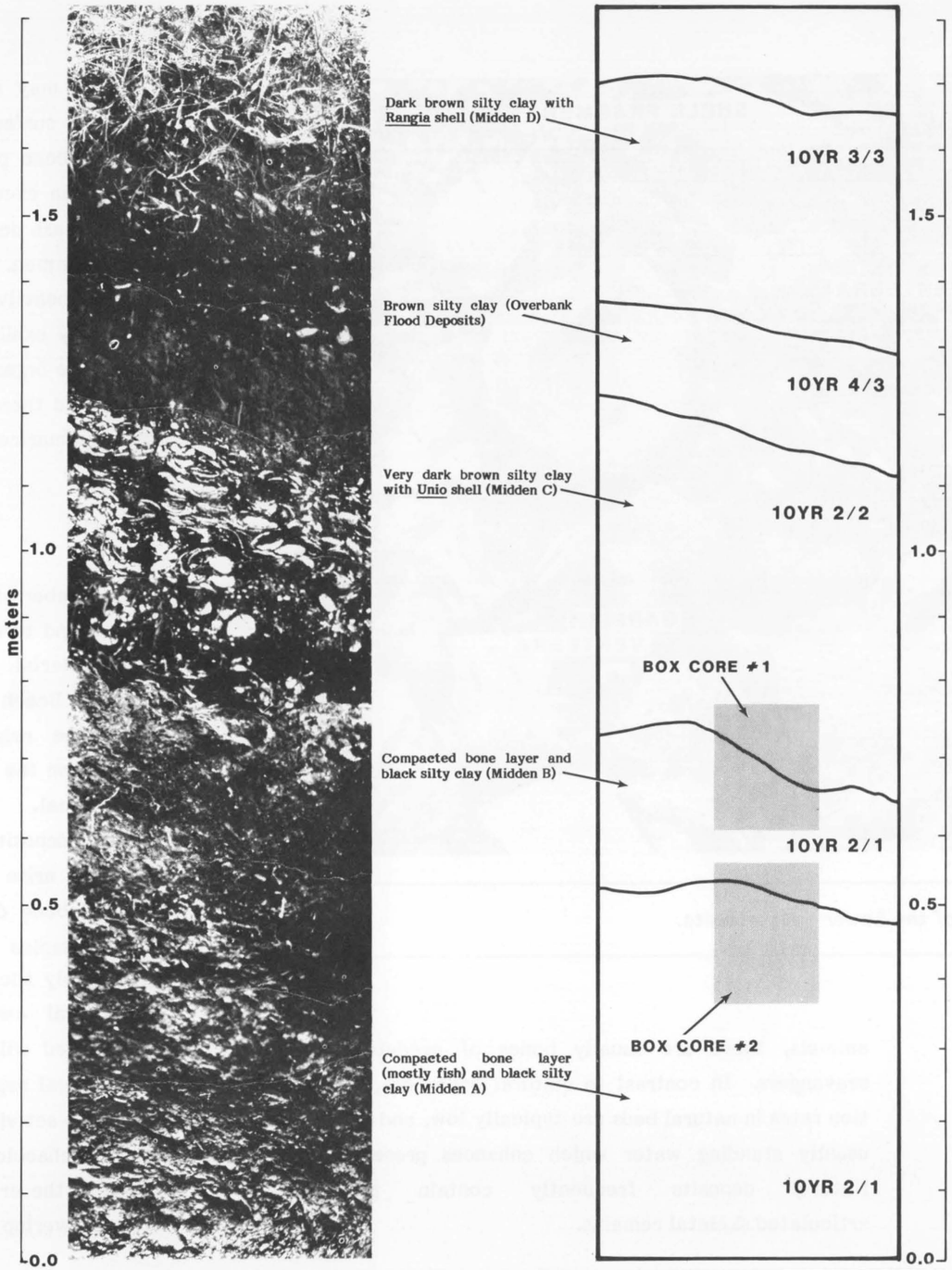


Figure 3-21A. Vertical section from the Lower Vacherie site.

LOWER VACHERIE SITE (16 SJ 2)

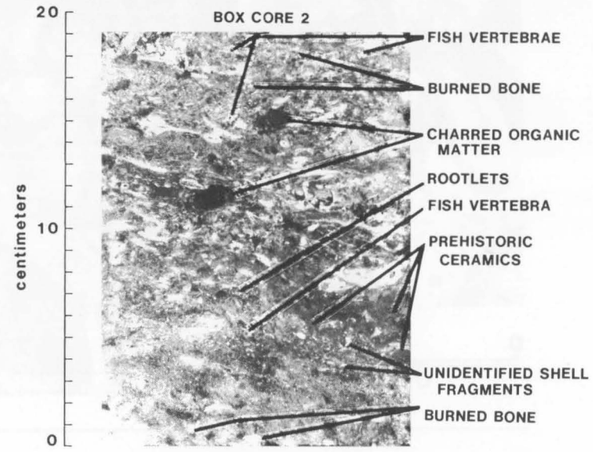


Figure 3-21B. Box core sample from the Lower Vacherie site.

DESCRIPTORS

INDICATOR PARAMETERS	OCCURRENCE	% TOTAL: 1: 10 to 19%	2: 20 to 29%	3: 30 to 39%	4: 40 to 49%	5: 50 to 59%	6: 60 to 69%	7: 70 to 79%	8: 80 to 89%	9: 90 to 100%	SIZE (Wentworth Scale): Cobbles (-6 to -8 phi units) 64 to 256 mm	Pebbles (-2 to -6 phi units) 4 to 64 mm	Granules (-1 to -2 phi units) 2 to 4 mm	Very Coarse Sand (0 to -1 phi units) 1 to 2 mm	Coarse Sand (1 to 0 phi units) .5 to 1 mm	Medium Sand (2 to 1 phi units) .25 to .5 mm	Fine Sand (3 to 2 phi units) .125 to .25 mm	Very Fine Sand (4 to 3 phi units) .0625 to .125 mm	Silt (8 to 4 phi units) .00391 to .0625 mm	Clay (8 phi units) .00391 mm	SORTING: Poorly Sorted	Well Sorted	Uniform	PARTICLE CONDITION: Whole	Broken	Rounded	Angular
MAJOR CONSTITUENTS (80% or more)																											
CLASTIC SILICATES																											
Gravel																											
Sand																											
Silt	●		●																●		●						
Clay																											
ORGANICS																											
Shell																											
Marine																											
Crassostrea																											
Rangia																											
Freshwater pelecypods																											
Other																											
Bone	●								●			●	●								●	●			●		
Large mammals																											
Small mammals	●																										
Reptiles																											
Fish	●																										
Birds																											
Other																											
Plant																											
Wood																											
Leaves, twigs, etc.																											
Peat																											
Fibrous or grassy																											
Woody																											
Other																											
ARTIFACTS																											
Ceramics																											
Pottery																											
Fired Clay																											
Stone																											
Bone																											
Shell																											
Wood or Fiber																											
INCLUSIONS (20% or less)																											
Artifacts																											
Ceramics																											
Pottery	●																										
Fired Clay																											
Stone																											
Bone																											
Shell																											
Wood or Fiber																											
Shell	●																										
Marine																											
Crassostrea																											
Rangia																											
Freshwater pelecypods	●																										
Other																											
Bone	C																										
Wood																											
Ash																											
Charcoal	●											●															
Sediment Balls																											
Nodules																											
Calcareous																											
Silicious																											
Iron																											
Other																											

INDICATOR PARAMETERS	OCCURRENCE	
COLOR		
Description	Light Brown to Pale Brown	
Munsell No.	10YR 6/2 to 6/3	
Homogenous		
Bedded		
Mottled	●	
Columnar		
BEDDING		
Thickness		
0-5 cm		
5-10 cm	●	
10-15 cm		
>15 cm		
Contacts		
Sharp		
Burrowed		
Gradational	⊖	
Angular		
Horizontal		
Angular	●	
X-bedded		
Lenticular		
Distorted	●	
BIOTURBATION		
Large root molds		
Small root molds		
Rootlets	●	
Large animal burrows		
Small animal burrows		
Other		

C = CHARRED

Table 3-15. *Macro-sedimentary characteristics of box core 2 sample from the Lower Vacherie site.*

sedimentary rocks. The organic constituents consist largely of ecofacts, or organic remains introduced into the site as a result of food procurement. Studies of species present, species variation, particle condition, and other characteristics of the remains making up the organic constituent aid in distinguishing ecofacts from natural shell and bone deposits.

Man's mark is left in the macro-parameters of a site's sediment (Table 3-16). In a number of ways these are related to human processes active during accumulation of the archaeological deposit. Most seem to be associated with food procurement and preparation. Shell seems to be primarily a by-product of shellfish harvesting for food, but in the coastal zone it probably also was used for building up living areas. Likewise, deposits consisting largely of bones are the result of fishing and hunting activities. A more subtle process may be the buildup of sediment associated with processing of plant materials brought into the habitation area. For example, the collection of roots and tubers for food and fibers may result in bringing a considerable volume of clastic detrital sediment into the site area through time. Much of the sandy or silty soil found in Archaic middens and sometimes attributed to "colluviation" may be derived from root and tuber procurement and processing.

Another important process, related at least in part to food preparation, is fire. The direct products of fire, charcoal and ash, are chemically very stable and therefore are well preserved. Heat also causes chemical alteration of adjacent sediment. Clayey soil becomes oxidized and baked. Feldspars and other minerals may be altered. Shell may be calcined. Particles of baked clay appear to be one of the most universal indicators of human process. Groundwater perculating through burned areas in shell deposits may result in the formation of "midden rock," which is more resistant to erosion than the uncemented deposits.

Mechanical packing and attrition of sediments in the site may result from pedestrian traffic, children's play, and other related activities. Such zones of crushed shell frequently have been noted in shell midden deposits. Crushed shell is also evident along modern footpaths on the surface of shell middens. It is reasonable to conclude that crushed shell and denser packing may characterize areas of intensive activity.

Another class of human activities which might be called "pit and fill" has expression in the macro-characteristics of the sediment in several ways. The most distinctive is the presence of clay or silt balls. These are lumps of sediment that have been displaced by digging and filling. The generally homogenous appearance of the deposits in Categories A and C, along with the total absence of laminated sediment is probably also a reflection of these processes.

summary

From the standpoint of gross composition, archaeological deposits investigated in this study can be classified as both clastic sedimentary rocks and organic

INDICATOR PARAMETERS	CATEGORIES A			B						C					D
	Mitchell Ridge - 41 GV 66	Caplen - 41 GV 1	Veazey - 16 VM 7,8	Pierre Clement - 16 CM 47	Morton Shell Heap - 16 IB 3	Temple - 16 LF 4	Bayou Cutler - 16 JE 3	Shotgun Shell - 16 SB 52	Jackson Landing - 22 HA 500	Smith Ridge - 16 CM 49	Jeff Simmons - 16 CM 84	Bayou Blue - 16 AL1	Magnolia Mound - 16 SB 49	Cedarland - 22 HA 506	Lower Vacherie - 16 SJ 2
MAJOR CONSTITUENTS (80% or more)															
CLASTIC SILICATES															
Gravel															
Sand	●	●	●								●			●	●
Silt					●	●	●			●		●	●		
Clay				●				●	●			●			
ORGANICS															
Shell															
Marine	●	●													
Crassostrea		●		●											
Rangia		●		●	●	●	●	●	●						
Freshwater pelecypods															
Other															
Bone															
Large mammals															
Small mammals															●
Reptiles															
Fish															●
Birds															
Other															
Plant															
Wood															
Leaves, twigs, etc.															
Peat															
Fibrous or grassy															
Woody															
Other															
ARTIFACTS															
Ceramics															
Pottery															
Fired Clay															
Stone															
Bone															
Shell															
Wood or Fiber															
INCLUSIONS (20% or less)															
Artifacts															
Ceramics															
Pottery	●	●	●	●		●	●		●	●	●	●	●		●
Fired Clay											●	●		●	
Stone				●								●			
Bone										●	C				
Shell															
Wood or Fiber															
Shell															
Marine	●		●												
Crassostrea		●												●	
Rangia			B			●			●				●		
Freshwater pelecypods															●
Other															
Bone			●	●		●			●				●	●	C
Wood					C										
Ash					●										
Charcoal	●				●	●					●	●	●		●
Sediment Balls						S						S			
Nodules															
Calcareous	R	R													
Silicious															
Iron		R										●	●		
Other															

INDICATOR PARAMETERS	CATEGORIES A			B						C					D
	Mitchell Ridge - 41 GV 66	Caplen - 41 GV 1	Veazey - 16 VM 7,8	Pierre Clement - 16 CM 47	Morton Shell Heap - 16 IB 3	Temple - 16 LF 4	Bayou Cutler - 16 JE 3	Shotgun Shell - 16 SB 52	Jackson Landing - 22 HA 500	Smith Ridge - 16 CM 49	Jeff Simmons - 16 CM 84	Bayou Blue - 16 AL1	Magnolia Mound - 16 SB 49	Cedarland - 22 HA 506	Lower Vacherie - 16 SJ 2
COLOR															
Description															
Munsell No.															
Homogenous			●	●			●	●	●	●	●				
Bedded	●	●										●			
Mottled					●	●						●	●	●	●
Columnar															
BEDDING															
Thickness															
0-5 cm															
5-10 cm		●				●									●
10-15 cm	●			●					●						
> 15 cm			●		●		●	●		●	●		●	●	
Contacts															
Sharp		●													
Burrowed		●													
Gradational	●		●			●			●			●			●
Angular															
Horizontal	●	●	●	●	●		●	●	●			●			
Angular															●
X-bedded						●									
Lenticular															
Distorted												●			●
BIOTURBATION															
Large root molds													●	●	
Small root molds				●				●	●	●	●	●	●	●	
Rootlets	●			●				S	●	●		●		●	●
Large animal burrows															
Small animal burrows												●	●		
Other															

R = REWORKED
B = BURNED
C = CHARRED
S = SILT

Table 3-16. Occurrence of macro-sedimentary parameters by site.

CHAPTER IV

MICRO-SEDIMENTARY CHARACTERISTICS

A series of analyses was conducted on the samples taken from each of the 15 sites, the intent of which was to develop criteria for characterizing cultural deposits and distinguishing them from noncultural, natural deposits. Scale of analysis ranged from a consideration of the gross structure of the deposit from which core samples came (already discussed), through macroscopic features of the core, to microscopic analysis of sample constituents and, finally, to chemical analysis.

To maximize the usability of this study, the techniques of analysis selected for use were ones which can be practically applied and are readily accessible to most researchers. Since the methods of analyses used are relatively new in terms of their application to archaeological sediments (see Davidson and Shackley 1976 for a variety of applications of geoarchaeological techniques), the laboratory procedures utilized in each analysis are described in some detail.

As mentioned earlier, two types of samples were taken in the field. One type consisted of those taken from the identified cultural deposits. These consisted of one or, more commonly, two box cores and two or three shovel scoops from various parts of the site. This series of on-site samples was taken to provide some information on inter-site variability in future analyses. In the present discussion only those on-site samples derived from box cores were considered in analysis.

The other type of sample taken was the off-site, or control sample, derived from the landform on which the site is located. Again, though several control shovel scoops were taken, only one from each landform is considered in the following analyses. Landform-derived samples were subjected to the same analytical procedures as those taken on-site. More exhaustive and in-depth analytic treatment of similar landform sediments can be found elsewhere. (For example, see Fisk 1947; Byrne et al. 1959; Coleman and Gagliano 1964; Coleman 1966; Kolb and van Lopik 1966; Krinitzsky and Smith 1969; Nelson and Bray 1970; Kolb et al. 1975.)

In the field, the box cores were first transferred from the metal coring box to a specially made heavy cardboard box lined with plastic sheeting so that the metal coring boxes could be immediately reused. In the laboratory, the core face was cleaned and photographed in both black and white and color. Approximately 200-300 g (dry weight), of sample were then shaved from the portion of the core face representing cultural deposits for point count analysis. An additional sample (circa 200-300 g) was also removed from the box core as a geochemical sample. A third box core sample, weighing between 100 and 350 g (dry weight), was set aside for grain size analysis. Both the sample for point count analysis and the sample for grain size analysis were allowed to soak in a Calgon solution to aid in breaking up clumps of soil and in dispersing clays. After sampling, each core was impregnated with a glue (Elmers)/water mixture and allowed to harden. Then the hardened core was sliced with a band saw and one face was cleaned, recorded, and photographed. This last set of procedures enabled the previous discussion on core sedimentary structures.

The use of identifiable archaeological sites on known natural landforms allowed a system of analysis aimed at differentiating the cultural deposits from natural deposits by a basic standard procedure, and at attempting to explain or account for difference by correlation of grain size, point count, and chemical analyses. The procedures and results of each of these specific techniques are discussed below.

size distributions

Grain size analyses have long been used to estimate or aid hypotheses of depositional environments of natural sediments (Krumbein 1934; Krumbein and Pettijohn 1938; Folk and Ward 1957; Buller and McManus 1972, 1974). The most successful results have come from comparison of third and fourth statistical moments of grain size interval distributions. While such detail of analysis was beyond the scope of this endeavor and held little promise of establishing a standard for cultural deposits, a basic grain size analysis was considered useful in delineating the nature and origin of selected cultural deposits. Analysis of the archaeological deposits as sedimentary units within a natural-cultural depositional system consisted of a systematic procedure derived from standard grain size analysis established by Folk (1968).

Samples were considered to consist of soil "grains" of three major size categories: grains larger than 2 mm, grains between 2 mm and .062 mm, and those less than .062 mm. These categories represent standard divisions of grain size in geology and correspond respectively to the terms gravel, sand, and silt and clay. Silt and clay are grouped in one category because the time-consuming procedure necessary to distinguish them offered data of little use in distinguishing cultural and natural environments within the scope of this study. The goal of this analysis was to measure the proportion by weight of each of these size categories in a given sample and further subdivide the greater than .062 mm categories to estimate size distributions of the larger grains. The analysis included all material in the sample, not exclusive of culturally derived constituents.

The samples were soaked in a Calgon solution for 24 hours to disperse clays before drying, then dried at 75-80°C in a drying oven. A dry weight before washing was measured and the sample again soaked in Calgon solution to further disaggregate clays and aid in washing. Samples were then washed through a 230-mesh wet sieve with a water jet and gentle agitation until all silt and clay were removed. The washed sample was then dried and weighed. Subtraction of this weight from the prewashed sample weight provided the weight of the silt and clay fraction.

Further division of the coarse fraction (greater than .062 mm) is based on the standard phi division. Phi divisions are logarithms of grain size diameters, used because many size distributions in nature have been found to be log normal, i.e., produce a normal distribution (bell curve) with a logarithmic abscissa and an arithmetic ordinate. Five to eight 1 phi divisions of the coarse fraction were made using standard 8-in sieves vibrated in a mechanical shaker for 15 minutes. The weight of each phi division was measured to .01 g on a Metler balance. The measured weights were used to construct cumulative curves of grain size distributions.

These curves characterize the grain size distribution of each of the on-site and off-site samples. Differences and similarities among site samples as well as between site samples and their associated off-site (landform) samples were examined through visual observation of the curves. In the following discussions, the on-site samples considered consist of those derived from box cores. These are the same core samples utilized in later point count and geochemical analyses.

Grain size distribution curves for landforms and sites on these landforms are shown in Figure 4-1. Minor and major levee sites have been combined since there are few differences in the grain size distributions of sediments from these two landforms. Distribution curves for natural levee sediments are derived from

control samples taken near sites 16 SB 49 (major levee) and 16 SJ 2 (minor levee). Subsidence prevented the aquisition of control (off-site) samples at other locales.

The size distribution of natural levee soils is distinguished by extremely high percentages of silt and clay size particles. As shown in Figure 4-1, over 90% of the weight of the two levee soil samples is composed of materials smaller than silt size (greater than 4 phi). With a single exception, the sites located on natural levees are quite distinctive from the landform. They exhibit much greater amounts of sand-sized and larger particles. The majority of these larger particles is comprised of shell fragments, though ceramics, bone, and charred organic material occur. The distribution of one sample from 16 SB 49 is almost indistinguishable from the natural levee curves. Considering that this sample is from an earthen burial mound constructed of levee soils, this is not surprising. In most instances, however, it appears that cultural activities introduce or concentrate a variety of materials (shell, ceramics, bone, etc.) which result in an easily distinguished increase in the larger end of the grain size scale. The curves of the site deposits themselves are quite variable, however, and reflect no consistency in site composition in terms of grain size distributions.

Two other sites, 16 IB 3 and 16 LF 4, are compared against a typical natural levee grain size distribution in Figure 4-1. Although these sites are associated with non-levee landform settings (salt dome margin and lake margin), they are located on levee soils, now subsided at both sites. The introduction of items of large grain size, primarily Rangia shell,

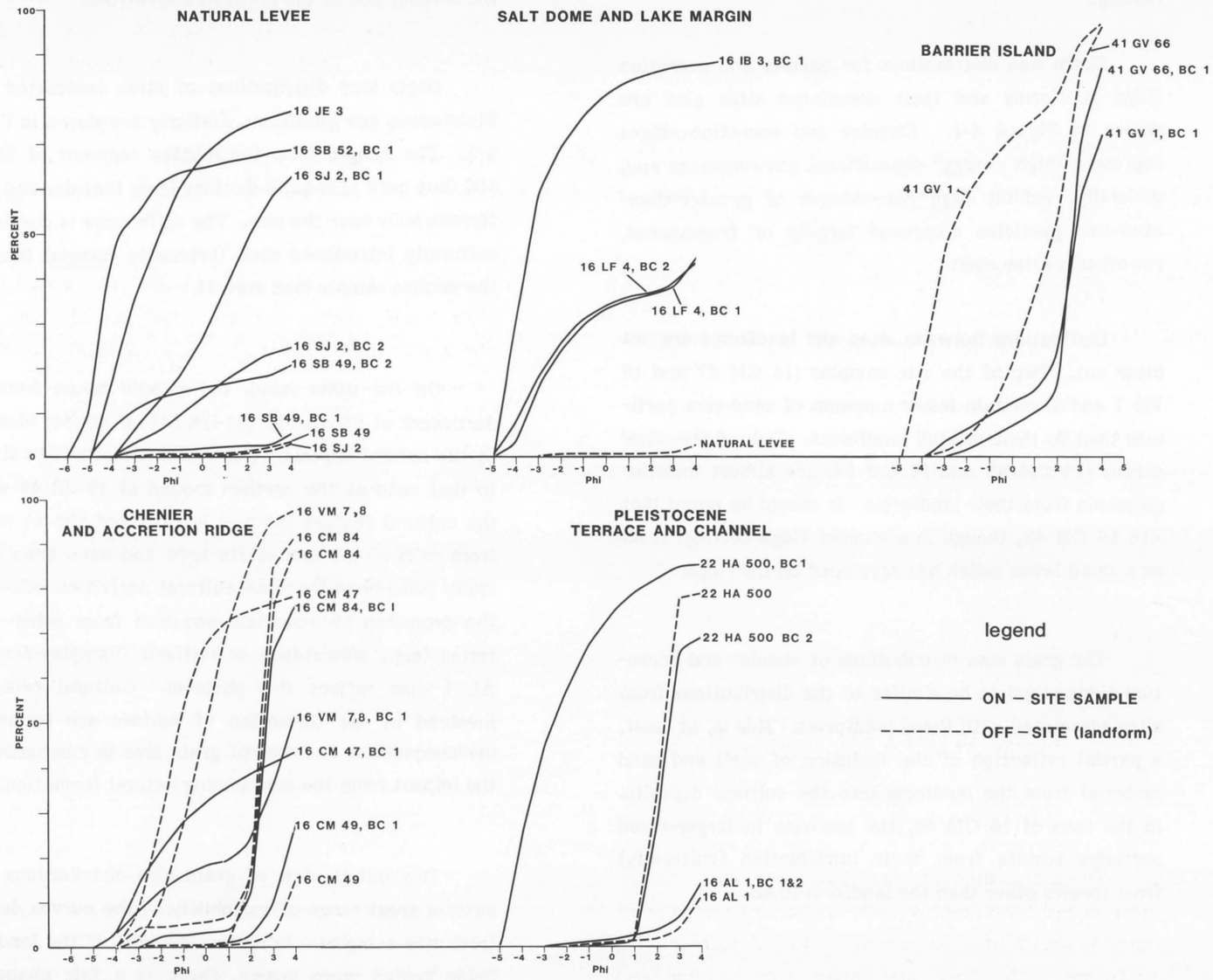


Figure 4-1. *Grain size distribution curves for sites on selected landforms.*

through cultural activities makes these two site curves quite distinctive from the soils on which they are resting.

Grain size distributions for chenier and accretion ridge landforms and their associated sites also are shown in Figure 4-1. Chenier and accretion ridges represent "high energy" depositional environments and, generally, exhibit high percentages of greater-than-sand-size particles composed largely of fragmented, reworked marine shell.

Distinctions between sites and landforms are not clear cut. Two of the site samples (16 CM 47 and 16 VM 7 and 8) contain lesser amounts of sand-size particles than do their related landforms. Two of the sites' curves (16 CM 49 and 16 CM 84) are almost indistinguishable from their landforms. It should be noted that site 16 CM 49, though in a chenier ridge setting, rests on a small levee which has developed on the ridge.

The grain size distributions of chenier and accretion ridges tend to be similar to the distributions from sites associated with these landforms. This is, at least, a partial reflection of the inclusion of shell and sand material from the landform into the cultural deposits. In the case of 16 CM 49, the increase in larger-sized particles results from their introduction (culturally) from locales other than the landform itself.

The relationship between the grain size distributions of samples from barrier island sites and samples from their associated landform is similar to that seen for chenier and accretion ridge sites. The shapes of all four barrier island curves in Figure 4-1 are roughly similar. However, the site samples are shifted toward the smaller end of the grain size spectrum.

Grain size distributions of sites associated with Pleistocene age landforms similarly are shown in Figure 4-1. The sample from the midden segment of 22 HA 500 (box core 1) is quite distinct from that derived from terrace soils near the site. The difference is due to the culturally introduced shell (primarily Rangia) found in the midden sample (box core 1).

On the other hand, the sample taken from the earthwork at 22 HA 500 (22 HA 515) is almost identical to the natural deposit. This reflects a situation similar to that seen at the earthen mound at 16 SB 49 where the cultural feature samples are derived almost totally from soils of the immediate area and have been minimally influenced by those cultural activities related to the depositon of materials acquired from other landforms (e.g., subsistence activities). Samples from 16 AL 1 also reflect this pattern. Cultural processes involved in the formation of midden are apparently inconsequential in terms of grain size in comparison to the impact from the surrounding natural formation.

This initial view of grain size distributions indicates a great range of variability in the curves derived from site samples. In some instances, if the landform being tested were known, there is a fair chance of determining whether or not cultural deposits have been encountered through the use of grain size distributions. This is especially true on natural levee landforms where cultural activities can be expected to introduce significant amounts of larger-sized particles than exist in the landform.

The identification of cultural deposits becomes more difficult, however, when the landforms themselves contain mainly sand-sized or larger particles. In these cases, either the bulk of these larger particles is derived from the landform on which occupation occurs, or cultural activities tend to result in the accumulation of particles similar in their distribution by size to those found in the natural deposit.

In addition to the above, grain size distribution curves from all site samples were visually compared. Although a great deal of variation is evident in these curves, patterns are present which allow the grouping of curves into four types based on similarities in shape (Figure 4-2). Presumably certain aspects of the composition of the midden matrix at these sites are similar.

Type I site samples (16 VM 7 and 8, 16 CM 84, 41 GV 1, 41 GV 66) reflect relatively well-sorted material with a high concentration of particles in the 2-3 phi (fine sand) range. These are all sites from cheniers, accretion ridges, or barrier islands and their grain size distributions suggest that the bulk of both the shell and clastics in these types of middens is derived from the natural environment in which the midden has accumulated.

The sites included in the Type II group are 16 IB 3, 22 HA 500, 16 JE 3, and 16 SB 52 (Figure 4-2). These samples are represented by more well-sorted material

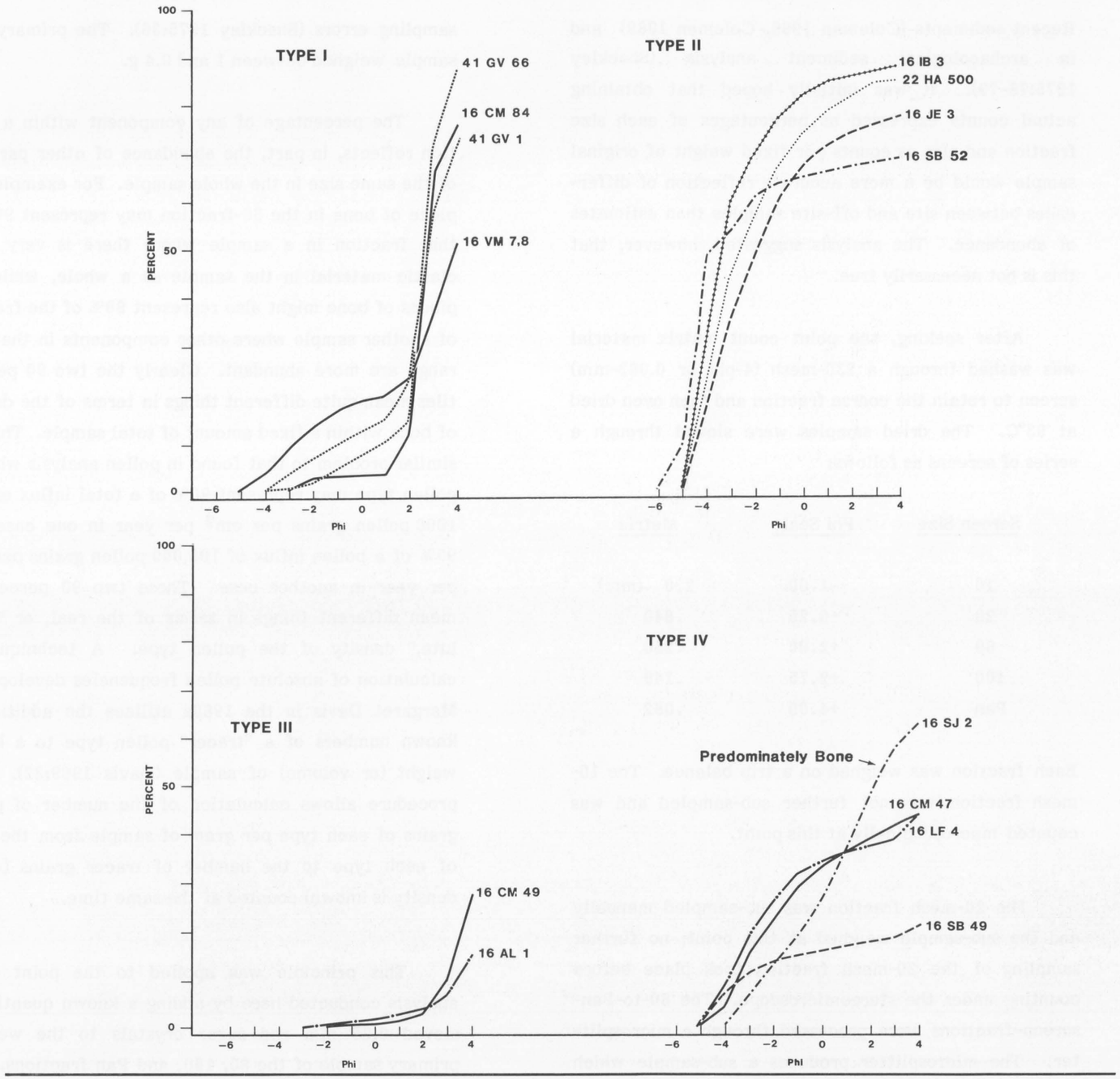


Figure 4-2. *Grain size curves of individual sites visually grouped by type.*

than is found in Type I sites and the particles tend to be larger. In all of these samples, the majority of the material is larger than -1 phi (very coarse sand). These samples are composed largely of shell, primarily Rangia. These Type II sites typify the massive Rangia shell midden sites known from coastal Louisiana.

The two sites included in the Type III category, 16 AL 1 and 16 CM 49, exhibit grain size distribution in which the majority of the material is silt size (4 phi) or smaller. Although in different landform settings, both of these sites are located on levee soils and in terms of grain size distribution, their midden make-up is little different from that of their associated landform.

Type IV sites consist of a variety of curves which are not readily classified. It is apparent that, for probably a variety of reasons, cultural processes at these sites have been dominant in terms of their contribution to midden formation.

The comparison of the grain size distributions of sites suggests that patterns exist which may eventually be useful in classifying as well as in identifying sites. The relatively small sample available here prevents the development of tightly drawn conclusions about the data. However, it appears that grain size analysis has the potential for allowing a "site"/"nonsite" decision in those instances where cultural factors have altered the midden to such an extent that its particle size composition no longer mimics that of the landform on which it is found. It is apparent that cultural forces tend to introduce sand-size and larger particles; therefore, the effects of cultural activity should be most obvious when dealing with those landforms made up of smaller-than-sand-size particles, e.g., natural levees.

point count analysis

The term "point count" is derived from a technique used in sedimentary petrography in which the proportions of various mineral components in a sample are determined by counting the individual grains underlying a network of points placed over a thin section (Muller 1967:145). Counting of individual grains (as opposed to subjective estimates of abundance) has been a standard practice since the 1920s in studies of the mineral content of the heavy fraction of sediment samples (Krumbein and Pettijohn 1938:470). Estimates of abundance, however, are still used in characterizing the general content of sediment samples in the study of Recent sediments (Coleman 1966, Coleman 1969) and in archaeological sediment analysis (Shackley 1975:78-79). It was initially hoped that obtaining actual counts expressed as percentages of each size fraction and also as counts per fixed weight of original sample would be a more accurate reflection of differences between site and off-site samples than estimates of abundance. The analysis suggested, however, that this is not necessarily true.

After soaking, the point count matrix material was washed through a 230-mesh (4-phi or 0.062-mm) screen to retain the coarse fraction and then oven dried at 93°C. The dried samples were sieved through a series of screens as follows:

Screen Size	Phi Scale	Metric
10	-1.00	2.0 (mm)
20	+0.25	.840
60	+2.00	.250
100	+2.75	.149
Pan	+4.00	.062

Each fraction was weighed on a trip balance. The 10-mesh fraction was not further sub-sampled and was counted macroscopically at this point.

The 20-mesh fraction was sub-sampled manually and the sub-sample weighed at this point; no further sampling of the 20-mesh fraction took place before counting under the stereomicroscope. The 60-to-Pan-screen-fractions were processed through a microsplitter. The microsplitter produces a sub-sample which retains the approximate proportions of the components of very small items. However, it is still subject to sampling errors (Shackley 1975:36). The primary sub-sample weighed between 1 and 0.4 g.

The percentage of any component within a fraction reflects, in part, the abundance of other particles of the same size in the whole sample. For example, one piece of bone in the 60-fraction may represent 90% of that fraction in a sample where there is very little clastic material in the sample as a whole, while 300 pieces of bone might also represent 90% of the fraction of another sample where other components in that size range are more abundant. Clearly the two 90 percentiles mean quite different things in terms of the density of bone within a fixed amount of total sample. This is a similar problem to that found in pollen analysis where a pollen type may represent 90% of a total influx of only 1000 pollen grains per cm^2 per year in one case, but 90% of a pollen influx of 100,000 pollen grains per cm^2 per year in another case. These two 90 percentiles mean different things in terms of the real, or "absolute," density of the pollen type. A technique for calculation of absolute pollen frequencies developed by Margaret Davis in the 1960s utilizes the addition of known numbers of a "tracer" pollen type to a known weight (or volume) of sample (Davis 1969:32). This procedure allows calculation of the number of pollen grains of each type per gram of sample from the ratio of each type to the number of tracer grains (whose density is known) counted at the same time.

This principle was applied to the point count analysis conducted here by adding a known quantity of sieved 0.25 mm red sugar crystals to the weighed primary sample of the 60, 100, and Pan fractions. The primary sample was then further split to obtain a countable number of grains. The final sub-sample of

200 to 700 grains was counted in its entirety. A 500-grain figure was decided upon as a goal for several reasons. In a test run, the percentages of various components were calculated at increasing sample sizes up to 2000 grains. It was found that at about 500 grains the percentages of components ceased to fluctuate radically. Sample sizes of between 200 and 400 grains are standard in studies of foraminifera, pollen analysis (Martin 1970:31), and sedimentary petrography (Krumbein 1938:471). The probable error associated with various percentages of components at various sample sizes can be determined mathematically and is shown graphically in Figure 4-3. It can be seen that the probable error ceases to decrease rapidly after about 300 grains.

The final sub-sample of the 20 to Pan fractions was sprinkled onto a 1 cm (or 1 mm, depending on the size of the fraction) gridded card covered with spray glue. The spray glue remained tacky so that grains could be manipulated for identification but air currents could not dislodge them. Counting was done with the aid of a stereomicroscope at 7x-30x magnification.

Identification was facilitated by the preparation of "particle reference standards" (Shackley 1975:79), a series of slides of sieved fragments of various materials likely to be encountered in the analysis. Hydrochloric acid was sometimes used to distinguish carbonates from silicates.

Certainly not every particle present in the sample was counted and probably not every particle counted was correctly identified. However, an effort was made to come as close to this ideal as possible. There are additionally, of course, many problems in this type of analysis. (For instance, how many "particles" of root fiber are there in a clump of root fibers? Is this particle a piece of ceramic or a piece of baked clay?) The point technique does, however, appear to be a reasonable, efficient, and practical approach to the study problem.

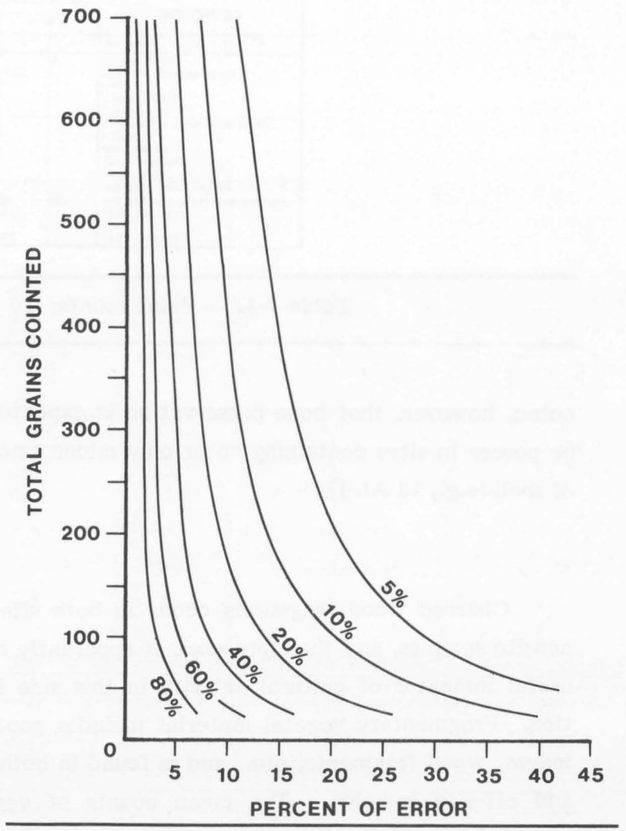


Figure 4-3. *Curves for estimation of probable error of samples (After Krumbein 1938).*

Biotic components were identified to the highest taxonomic level possible. These taxa are not listed in the tables, but are presented in the discussion. Considering the small size of the samples counted (weighing a fraction of a gram), the frequency of occurrence of biotic items such as snails and seeds is remarkable. Another remarkable discovery was the abundance of small fragments of bone in midden samples. The total volume of bone which usually escapes the archaeologists' notice because of its small size may be at least as great as that which is retrieved through screening.

The results of the point count analysis of each of the five size fractions which were separated out for each on-site and each off-site sample are presented in a series of tables (4-1 through 4-5) which follow in this section. A brief discussion offering interpretations of the significance of these counts accompanies each table. The discussions are broken down into major components, those items which make up the bulk of the sample, and minor components, those items whose occurrence is rare and sporadic. Statistical treatment of the point count data is presented at the end of this section.

10 FRACTION

Because the 10 fraction contained all items larger than 2.0 mm, great size variation is represented. It was not felt necessary to further subdivide this fraction in the present analysis, however, future work may suggest the need for further breakdown of this largest-sized fraction.

Major Components: Shell comprises the most numerous item in this size fraction (Table 4-1). As expected, those sites located at distances from natural shell beds contain little or no shell. Two of the chenier/accretion ridge sites (16 CM 84, 16 CM 49) contained no shell in this size fraction and very little was observed in the smaller size fractions, despite the fact that shellfish were presumably accessible. The amount or presence of shell does not appear to be a significant factor in distinguishing sites from nonsites. The types of shells that occur, however, do vary between sites and nonsites. The brackish water clam (Rangia cuneata) occurs in over half of the site samples, yet was identified in only two off-site samples. A total of 16 different categories of shellfish were identified in all samples. Site samples containing shell had an average of 3.1 shellfish categories represented, most often brackish water clam or oyster (Crassostrea virginica), while the off-site samples with shell contained an average of 7.7 of the identified shellfish categories, reflecting primarily several varieties of marine shell.

All identified bone came from site samples, although several fragments of crab (?) claw were found in two of the off-site samples. The majority of bone fragments which could be identified, despite heavy fragmentation, are fish. Garfish (Lepisosteous sp.) elements, especially scales, were common and catfish (Ictaluridae sp.) and drum (Aplodinotus grunniens) were also identified. Rigorous analysis of the faunal materials would result in the identification of many more than these easily identified types. The indications are that the occurrence of bone in this size fraction is a fairly reliable indicator of a cultural deposit. It is noted, however, that bone preservation is expected to be poorer in sites containing no or only minor amounts of shell (e.g., 16 AL 1).

Charred wood fragments occur in both site and nonsite samples, and their presence is apparently not a useful indicator of cultural activity in this size fraction. Fragmentary vegetal material includes rootlets, leaves, wood fragments, etc., and is found in both site and off-site samples. The mean counts of vegetal material are similar for site and nonsite samples, and this category is not useful in distinguishing between sites and nonsites.

Minor Components: Iron nodules occur in the samples from the two barrier island sites (41 GV 66 and 41 GV 1), the Pleistocene terrace site (16 AL 1) and two of the Pleistocene terrace/estuarine margin sites (22 HA 500 and 22 HA 506). Examination of the occurrence of iron nodules in the off-site samples indicates the probability that iron nodules in the site samples are inclusions derived from the landform on which the site is located.

Land snails (Hawaiia miniscula, Gastrocopta sp., and Pupisoma sp.) occur only in site samples. It is expected that when found they may be indicators of cultural deposits. Snails might be expected to be

ON-SITE SAMPLES

COMPONENT	MAJOR NATURAL LEVEE			MINOR NATURAL LEVEE			CHENIER AND ACCRETION RIDGE				BARRIER ISLAND		ESTUARINE MARGIN/ PLEISTOCENE TERRACE			INCISED CHANNEL/ PLEISTOCENE TERRACE		SALT DOME MARGIN		LAKE MARGIN		MEAN VALUE ALL SITES
	16 JE 3	16 SB 49		16 SB 52	16 SJ 2		16 VM 7,8	16 CM 47	16 CM 84	16 CM 49	41 GV 66	41 GV 1	22 HA 500		22 HA 506	16 AL 1		16 IB 3		16 LF 4		
BOX CORE No.	1	1	2	1	1	2	1	1	1	1	1	1	1	2	1	1	2	1	2	1	2	
Iron nodule											61	155		10	3	263	338					39.52
Cemented sand or silt				16			35					18										3.28
Flake	2								5						5							0.57
Iron				22																		1.04
Lead shot				1																		0.04
Baked clay	8				316	55					4				97			15				23.57
Ceramics	96		44	18	77	24	82	27	72	110	4		2						37		38	30.04
Mussel shell	5																			52		2.71
Oyster shell	49						14	60			48	173	7		3							16.71
Brackish-water clam shell	468	22	117	620	20	3	18	182				8	951					722	225	202	307	184.04
Fresh-water mussel shell					125																	5.95
Marine shell							127	4			557	245						5				44.66
Unidentified shell	285	61	337	2196	1696	9	1088	911			448	1781	4073		21			2593	608	591	1150	849.90
Land snails							14	3			48	5						5				3.57
Crustacean fragment				1																		0.04
Bone, teeth, scales	69	22	70	115	2177	2243	129	468	15		69		52		832			150	30	21	139	314.33
Vegetal material, fragmentary		61	66	67	129	47	1	12	66	103	121	269	7	73	37	87	9					55.00
Charred material	26				8	68	42	36	5	3	8		9	7	34	32	11	5	21	41		16.95
Ash																					34	1.61
Seeds											4	8										0.57
Unidentified			4	4		68					4				593				2		5	32.88

OFF-SITE SAMPLES

COMPONENT	MAJOR NATURAL LEVEE			CHENIER AND ACCRETION RIDGE			BARRIER ISLAND	PLEISTOCENE TERRACE		OYSTER REEF		MEAN VALUE ALL OFF-SITES
	16 SB 49		NATURAL LEVEE	16 VM 7,8	16 CM 84	16 CM 49	41 GV 1	ESTUARINE 22 HA 500	CHANNEL 16 AL 1	OYSTER REEF		
SAMPLE No.	2	3		2	1	3	1	1	2			
Iron nodule	4				29	5	126		271	53		48.80
Cemented sand or silt		167			10				16			19.30
Iron						19						1.90
Mussel shell										100		10.00
Oyster shell				483	10		226			896		161.50
Brackish-water clam shell				61	3							6.40
Barnacle										144		14.40
Wedge clam										67		6.70
Marine shell				1021	92		437			77		162.70
Unidentified shell				5902	241		2117			1860		1012.00
Crustacean fragment					3					3		0.60
Vegetal material, fragmentary	199	75				71		137	4	3		48.90
Charred material	13	343				61		26	8			45.10
Seeds						52		3		3		5.80
Unidentified		25										2.50

Table 4-1. Point counts: 10 fraction expressed in particles per kilogram.

common in Indian middens because of the presence of decaying organic matter on which they feed, and thus may be site indicators. Certainly they are useful in distinguishing terrestrial from marine environments.

Flakes were identified in three site samples and ceramics in eleven of the site samples. The ceramics are, of course, positive indicators of cultural deposits, although they cannot be expected to occur in most submerged sites. The scarcity of lithic material is demonstrated by the occurrence of lithics in only three of the site samples and then only in low frequencies. The chances of picking up lithics in a core-size sample from a site are small. Additionally, small flakes resembling culturally treated stone can occur naturally.

Items identified as baked clay occur in several site samples. These may be eroded ceramic pieces or fragments of daub, firepits, and the like. The occurrence of baked clay would appear to be a definite site indicator. This should be accepted with some caution, however, since natural fires often produce similar fragments of baked clay. The lead shot and iron found in the sample from site 16 SB 52 represent modern contamination.

20 FRACTION

Major Components: High shell values in the site samples are due to the nature of the midden and the nature of the substrate (Table 4-2). Chenier ridge and barrier island shell became incorporated in middens located in these enivornments. Small amounts of shell were observed in natural levee and Pleistocene terrace

ON-SITE SAMPLES

COMPONENT	MAJOR NATURAL LEVEE			MINOR NATURAL LEVEE			CHENIER AND ACCRETION RIDGE				BARRIER ISLAND		ESTUARINE MARGIN/ PLEISTOCENE TERRACE			INCISED CHANNEL/ PLEISTOCENE TERRACE		SALT DOME MARGIN		LAKE MARGIN		MEAN VALUE ALL SITES
	16 JE 3	16 SB 49		16 SB 52	16 SJ 2		16 VM 7,8	16 CM 47	16 CM 84	16 CM 49	41 GV 66	41 GV 1	22 HA 500		22 HA 506	16 AL 1		16 IB 3		16 LF 4		
BOX CORE No.	1	1	2	1	1	2	1	1	1	1	1	1	1	2	1	1	2	1	2	1	2	
Clastics		2	1				16		5	6	9	12		59	8		2					4.71
Iron nodule		3	2									12		1		310	422					36.00
Cemented sand or silt																	4			6		0.47
Microflake									1	1						1						0.14
Red pigment									1	1												0.09
Iron				10						2												0.57
Baked clay	20				82	25						37	8					26	7	2	7	8.04
Ceramics	1	12	12	25			19	9	35	41								5	7	1	7	8.66
Unidentified shell	231	83	193	2745	2442	8	1047	570			2046	3392	2697	94	60			2913	320	408	625	882.28
Land snails	3			15			8	3			18		16					15		1	2	3.85
Bone, teeth, scales	298	33	54	371	6023	3733	221	472	54	38	241		45		2605			131	23	34	192	705.19
Insect carapace									1													0.04
Pupa or egg case									81		18											5.57
Charred skin(?)															8							0.38
Vegetal material, fragmentary	29	138	16	177	46	112	14	26	106	76	415	666	8	68	31	105	2	43	12			87.57
Charred material	61	70	5		82	209	30	72	6	11	106		8	5	52	57	4	95	100	11	26	53.14
Berry										1												0.04
Seeds				5			3		1	1	9				8							1.27
Unidentified																1						0.04

OFF-SITE SAMPLES

COMPONENT	MAJOR NATURAL LEVEE			CHENIER AND ACCRETION RIDGE			BARRIER ISLAND	PLEISTOCENE TERRACE		OYSTER REEF	MEAN VALUE ALL OFF-SITES
	16 SB 49		NATURAL LEVEE	16 VM 7,8	16 CM 84	16CM 49	41 GV 1	ESTUARINE 22 HA 500	CHANNEL 16 AL 1	OYSTER REEF	
SAMPLE No.	2	3		2	1	3	1	1	2		
Clastics					4			2			0.60
Iron nodule	3		10		4				176	159	35.20
Cemented sand or silt									11		1.10
Iron						19					1.90
Marine snails				23							2.30
Unidentified shell	1	4	94	7483	305	1	1582	2	1	3228	1270.10
BONE, teeth, scales		2	20		3				1		2.60
Insect carapace		2									0.20
Pupa or egg case					1						0.10
Vegetal material, fragmentary	155	59	416	16	2						78.80
Charred material	7					22		102	6	10	6.30
Seeds	5	21				34		19	3		4.30
						16		1			

Table 4-2. Point counts: 20 fraction expressed in particles per kilogram.

off-site samples, probably due to contamination from modern shell roads or nearby Indian middens. The amount of shell is not particularly significant in distinguishing between sites and off-sites, although certain characteristics, such as the eroded appearance of barrier island and chenier ridge off-site shell and the obvious presence of marine shell in the oyster reef sample, may be useful.

Sixty to one-hundred percent of the bone in those samples for which determinations were made was fish bone. Garfish (Lepisosteus spp.) scales and fish teeth were occasionally encountered. Bone values in site samples vary with the type of economic activities carried on at the site but generally are high. Bone values for off-site samples analyzed for this project are very low, although fish bone is listed as "common" in modern cores from nearshore marine, brackish water bay, and swamp environments (Coleman 1966). In this size fraction, bone is considered one of the best indicators of a site, since the natural bone-accumulating environments listed above can often be distinguished by sedimentary structures, grain size, and other contents. Bone preservation, however, varies from site to site, and in highly acidic soils may not be preserved at all (e.g., 16 AL 1).

"Fragmentary Vegetal Material" includes primarily rootlets, but also leaf fragments, fibrous material, and wood splinters. The mean values for vegeta

materials in site and off-site samples are similar. Rootlets and wood are common to abundant in cores from several natural environments (Coleman 1966). While not an important distinguishing feature between sites and nonsites, vegetal material may be useful in distinguishing terrestrial from marine environments. Charred material is present in almost every site sample in this size fraction, and the mean value for sites is much larger than that for off-sites.

Minor Components: Iron nodules are associated with natural levee, barrier island, and Pleistocene terrace environments in the samples analyzed for the project. They also occur in modern salt marsh, fresh marsh, and swamp cores (Coleman 1966). While not particularly useful in distinguishing sites from nonsites, abundant iron nodules are indicative of the type of natural environment from which the sample was taken.

Microflakes were found in three site samples. Depending on the natural environment, their fortuitous presence suggests that a sample is site-derived, but caution is warranted in using this evidence since isolated, small fragments of naturally chipped chert might occur in a variety of environments.

Land snails include the species Hawaiia miniscula, Gastrocopta pellucida, G. cristata, and Pupisoma sp., of which the first was the most common. Land snails were only found in site samples. Identifiable seeds from the site samples include members of the family Malvaceae, the genera Euphorbia, Polygonum, Chenopodium, and Sceleria and the species Mullago verticulata, Phytolacca americana, and Portulaca olereacea. All except the last are from reasonably good midden contexts (that is, probably not derived from the surface) even though none are carbonized. All of these are open-field, weedy species except Phytolacca, which occurs in woods, and the sedge Sceleria. Polygonum is a weed but is also found in marsh environments. Of the off-site sample seeds, only seeds of Phytolacca americana were identifiable. The seeds in the samples clearly help to distinguish terrestrial from marine environments and there may also be a tendency for seeds of open-field, weedy plants to occur in site samples. This would be expected because of clearing and disturbance due to human activities at the site. Fragments of rusted iron found in two samples represent surface contamination.

60 FRACTION

Major Components: Mean values for clastics (small sand fragments or mineral grains), which become an important component in the 60 size fraction, are similar for site and off-site samples (Table 4-3). Clastic values appear to primarily reflect the natural environment of the site or off-site sample. The barrier island sites contain the most clastic material, followed by estuarine margin sites (those located on the Pleistocene terrace overlooking the estuary) and chenier and accretion ridge sites. These values are separated by several orders of magnitude from values for sites located on natural levees. (Note that 16 CM 49 is

ON-SITE SAMPLES

COMPONENT	MAJOR NATURAL LEVEE			MINOR NATURAL LEVEE			CHENIER AND ACCRETION RIDGE				BARRIER ISLAND		ESTUARINE MARGIN/ PLEISTOCENE TERRACE			INCISED CHANNEL/ PLEISTOCENE TERRACE		SALT DOME MARGIN		LAKE MARGIN		MEAN VALUE ALL SITES
	16 JE 3	16 SB 49		16 SB 52	16 SJ 2		16 VM 7,8	16 CM 47	16 CM 84	16 CM 49	41 GV 66	41 GV 1	22 HA 500		22 HA 506	16 AL 1		16 IB 3		16 LF 4		
BOX CORE No.	1	1	2	1	1	2	1	1	1	1	1	1	1	2	1	1	2	1	2	1	2	
Clastics		15	106	6	53		6636	146	47376	427	24164	42337	1144	87215	124832	45	6	3	1	1	11	15931.62
Iron nodule			2													157	823					46.76
Cemented sand or silt																					3	0.14
Red pigment							8															0.38
Baked clay	19																	4	2			1.19
Ceramics	9	3	16	13						52												4.42
Unidentified shell	1791	73	610	1094	5028	136	782	650	193	79	1324	1324	3990		1483			383	60	436	535	985.00
Foraminifera				17								139										7.42
Insect carapace									48													2.28
Bone, teeth, scales	5262	33	372	670	19690	61806	451	356	290	337	187		1049		20311			34	13	156	484	5308.62
Vegetal material, fragmentary	373	165	245	36	503	136		146	290	569	182	1019		352	455	304	14	6	3			299.67
Charred material	1847	41	112	26	106	3050	177	124	48	98	52		88	352	890	18	6	70	417	45	70	367.00
Seeds					53					8												2.90
Unidentified			10																	3		0.61

OFF-SITE SAMPLES

COMPONENT	MAJOR NATURAL LEVEE			CHENIER AND ACCRETION RIDGE			BARRIER ISLAND	PLEISTOCENE TERRACE		OYSTER REEF	MEAN VALUE ALL OFF-SITES
	16 SB 49		NATURAL LEVEE	16 VM 7,8	16 CM 84	16 CM 49	41 GV 1	ESTUARINE 22 HA 500	CHANNEL 16 AL 1	OYSTER REEF	
SAMPLE No.	2	3		2	1	3	1	1	2		
Clastics	485		33	7978	19552	6643	7567	75247	139	7662	12530.6
Iron nodule	486								683	378	154.7
Cemented sand or silt			3071						232		330.3
Iron						16					1.6
Unidentified shell			33	8477	220		2798		38	2309	1387.5
Insect carapace		22				16					3.8
Bone, teeth, scales				66				228			29.4
Vegetal material, fragmentary	28485	1273	832		60	1317	212	762	318	147	3340.6
Charred material	2395	203	65	66	40	24			131	21	294.5
Seeds		247	33								28.0
Unidentified						16					1.6

Table 4-3. *Point counts: 60 fraction expressed in particles per kilogram.*

actually situated on natural levee deposits overlying an accretion ridge.) Exceptions to these generalizations occur of course. Similar results were obtained in off-site samples, again with some variation probably due to sampling error. Sampling error becomes increasingly magnified in the smaller size fractions.

The amount of shell in the site and off-site samples is highly variable and no particular pattern is discernible. Likewise the values for fragmentary vegetal material are probably random. Neither of these components is considered significant in differentiating one environment from another or sites from off-sites.

Bone is present in most site samples and absent in most off-site samples and the mean values for the two groups differ greatly. Sites with high concentrations of bone in the 20 fraction show the same result in the 60 fraction. Bone is consistently absent at 41 GV 1, which is suspected of being primarily a burial site rather than a habitation site, and at 16 AL 1, where bone was apparently not preserved. The presence of bone in off-site samples is random. It may be present only in the 20 fraction at one site, or only in the 100 fraction at another site, and its association with other components is apparently unpatterned. This is in contrast to site samples, where bone is present or absent in several fractions. Indeed, some particles of bone in the off-site samples may actually be bone-colored clastics which were misidentified, thus accounting for the random behavior of the values. Charred material ceases to be particularly indicative of the presence of a site in the 60 size fraction.

Minor components: One foraminifera was recorded in the 60 fraction, Trochammina inflata, a marsh and tidal pass species. All examples were from the site samples. The low values for foraminifera are expected considering the types of natural environments which were sampled. In modern cores, foraminifera are abundant only in nearshore marine and brackish bay environments (Coleman 1966).

100 AND PAN FRACTIONS

Identification of particles in these size fractions becomes increasingly difficult and sampling error larger. Both these factors reduce the utility of the 100 and Pan fractions in distinguishing sites from nonsites. As can be seen in the counts, samples in these size fractions are overwhelmingly composed of clastic materials, often 99% of the count of the fraction (Tables 4-4 and 4-5). There is possibly a tendency for shell values to be higher in site samples in relation to off-site samples in the 100 and Pan fractions, perhaps indicating greater fragmentation of shell in the site samples. A single foraminiferal species recorded in the 100 and Pan fractions was Haplophragmoides wilberti, a marsh and tidal pass species from the 16 SB 49 (off-site #2) sample.

It is felt that there is little information to be gained from point counts of the 100 and Pan fractions which could not more easily be obtained in other manners (for example, by grain size analysis). Point counts should focus on the material larger than 0.25 mm for greatest efficiency in making site/nonsite designations.

ON-SITE SAMPLES

COMPONENT	MAJOR NATURAL LEVEE			MINOR NATURAL LEVEE			CHENIER AND ACCRETION RIDGE				BARRIER ISLAND		ESTUARINE MARGIN/ PLEISTOCENE TERRACE			INCISED CHANNEL/ PLEISTOCENE TERRACE		SALT DOME MARGIN		LAKE MARGIN		MEAN VALUE ALL SITES
	16 JE 3	16 SB 49		16 SB 52	16 SJ 2		16 VM 7,8	16 CM 47	16 CM 84	16 CM 49	41 GV 66	41 GV 1	22 HA 500		22 HA 506	16 AL 1		16 IB 3		16 LF 4		
BOX CORE No.	1	1	2	1	1	2	1	1	1	1	1	1	1	2	1	1	2	1	2	1	2	
Clastics	35	135	278	44	213	134	4008	275	36238	9347	80269	120647	840	25914	38100	2123	24995	38	39	175	206	16383.47
Iron nodule			1													107						5.14
Red pigment	1																					0.04
Baked clay					25	134												5				7.81
Ceramics	2																		5			0.33
Unidentified shell	89	29	124	1971	1254	486	17	275		80		13639	564		501			445	329	175	138	957.90
Foraminifera				11								372										18.23
Crustacean fragment	7																					0.33
Bone, teeth, scales	297	41	107	1465	6337	14339	33	409	37	119	243	882	253		8652	5		79	28	91	128	1797.38
Vegetal material, fragmentary		21		26		201		8	37	308	81	372				33			5			52.00
Charred material	129	43	62	111	353	1442	62	44	183	70	243		45		1819	152	93	95	1092	22	29	289.95
Unidentified		2	4	590									3								2	2.90

OFF-SITE SAMPLES

COMPONENT	MAJOR NATURAL LEVEE			CHENIER AND ACCRETION RIDGE			BARRIER ISLAND	PLEISTOCENE TERRACE		OYSTER REEF	MEAN VALUE ALL OFF-SITES
	16 SB 49		NATURAL LEVEE	16 VM 7,8	16 CM 84	16 CM 49	41 GV 1	ESTUARINE	CHANNEL		
SAMPLE No.	2	3		2	1	3	1	1	2		
Clastics	8	102	177	6381	29156	93034	11437	14766	7038	1881	16398.0
Iron nodule										10	1.0
Cemented sand or silt	84	964	4862								591.0
Unidentified shell				373			199			101	67.3
Foraminifera	3			3							0.6
Bone, teeth, scales				21	262				22		36.4
Vegetal material, fragmentary	22	968	287			69245	59	448	185	20	7117.5
Charred material	14	50	143	14		301		105	163		79.0
Unidentified	2										0.2

Table 4-4. Point counts: 100 fraction expressed in particles per kilogram.

ON-SITE SAMPLES

COMPONENT	MAJOR NATURAL LEVEE			MINOR NATURAL LEVEE			CHENIER AND ACCRETION RIDGE				BARRIER ISLAND		ESTUARINE MARGIN/ PLEISTOCENE TERRACE			INCISED CHANNEL/ PLEISTOCENE TERRACE		SALT DOME MARGIN		LAKE MARGIN		MEAN VALUE ALL SITES
	16 JE 3	16 SB 49		16 SB 52	16 SJ 2		16 VM 7,8	16 CM 47	16 CM 84	16 CM 49	41 GV 66	41 GV 1	22 HA 500		22 HA 506	16 AL 1		16 IB 3		16 LF 4		
BOX CORE No.	1	1	2	1	1	2	1	1	1	1	1	1	1	2	1	1	2	1	2	1	2	
Clastics	55	917	1784	170	67	34	8906	212	8253	8455	7446	9664	93	1474	1377	1025	1668	38	44	527	1752	2569.57
Unidentified shell	42	25	44	2189	117	12		11					220	6	15			88	564	28	75	163.61
Bone, teeth, scales	160	14	27	1286	493	1548		7	17	34			41		1322			21	52	6	70	242.76
Charred material	129	38	72	1281	53	119	9	3	25	17		49	4	9	165	2	22	101	1	31	35	103.04
Unidentified			6	50					3						12					3		0.34

OFF-SITE SAMPLES

COMPONENT	MAJOR NATURAL LEVEE			CHENIER AND ACCRETION RIDGE			BARRIER ISLAND	PLEISTOCENE TERRACE		OYSTER REEF	MEAN VALUE ALL OFF-SITES
	16 SB 49		NATURAL LEVEE	16 VM 7,8	16 CM 84	16 CM 49	41 GV 1	ESTUARINE 22 HA 500	CHANNEL 16 AL 1	OYSTER REEF	
SAMPLE No.	2	3		2	1	3	1	1	2		
Clastics	456	635	90	297		6379	1277	451	4455	155	1419.5
Cemented sand or silt	17		1457							7	148.1
Unidentified shell				15	39	19	37	2	9	11	13.2
Foraminifera	2		3								0.1
Bone, teeth, scales			21				53	4			6.0
Vegetal material, fragmentary	29	18	6	1							6.9
Charred material	23	9						4	9	1	5.2

Table 4-5. *Point counts: pan fraction expressed in particles per kilogram.*

STATISTICAL TREATMENT OF POINT COUNT DATA

Chi-square Presence/Absence Analysis: The Chi-square Test for Two Independent Samples (Siegal 1956: 104; using Yates Correction for small expected values) determines the probability that the placement of two or more groups of items into categories based on some characteristic of those items differs from that which would be expected if the placement resulted purely from chance. Relying on the point count results, it was desired to determine if the distribution of site samples and nonsite samples into "Component A present" or "Component A absent" categories was due to chance or whether there were real differences in the presence or absence of the component between the two groups.

Some apparent differences, such as the association of land snails only with site samples, turned out to be equally well explained solely by chance due to the smaller size of the off-site group of samples (i.e., the frequency of land snails in samples is so low that if only 10 off-site samples were observed, one would not expect to find any containing land snails, anyway).

Other distributions at the $p \leq 0.05$ level of significance proved to be unexplainable by chance alone. It is assumed that this is due to the operation of processes causing real differences in the presence or absence of these components between site and off-site samples. Those distributions which were determined to be significantly different using the Chi-square test are shown in Table 4-6.

COMPONENT	FRACTION				
	10	20	60	100	PAN
CLASTICS					
LAND SNAILS					
RANGIA SHELL	▒				
MARINE SHELL					
OYSTER SHELL					
SHELL, FRAGMENTARY				▒	
BONE, TEETH, SCALES	▒		▒	▒	
VEGETAL MATERIAL, FRAGMENTARY					▒
CHARRED MATERIAL		▒			
BONE AND CHARRED MATERIAL	▒	▒	▒	▒	
BAKED CLAY					
FLAKE					

Table 4-6. *Chi-square test for significance of differences between on-site and off-site samples based on presence/absence of various components at various pan sizes. ▒ Indicates significant at $p \leq 0.05$.*

Because these differences appear to be real, the components so distributed were considered to be good indicators of whether the sample was or was not a site. The "reliability" of the component as a site predictor has been evaluated by the calculation of a set of percentages shown in Table 4-7. In an effort to make these values more realistic, percentages have been developed assuming an equal number of site and non-site samples. These percentages represent the

FRACTION AND COMPONENT	PERCENTAGE	
	COMPONENT PRESENT	COMPONENT ABSENT
10 FRACTION		
RANGIA SHELL	76%	29%
BONE, TEETH, SCALES	100%	19%
BONE AND CHARRED MATERIAL	100%	29%
20 FRACTION		
CHARRED MATERIAL	69%	13%
BONE AND CHARRED MATERIAL	88%	20%
60 FRACTION		
BONE, TEETH, SCALES	80%	19%
BONE AND CHARRED MATERIAL	89%	17%
100 FRACTION		
SHELL, FRAGMENTARY	72%	25%
BONE, TEETH, SCALES	69%	14%
BONE AND CHARRED MATERIAL	81%	15%

Table 4-7. *Likelihood that sample is site derived based on presence/absence of various components.*

likelihood that a sample is from a site when the particular component is present and when it is absent. The percentages reflect only the 31 samples used in the study, and only those components determined significant by Chi-square. However, they are probably representative to some degree of site and nonsite environments as a whole and can be used as one criterion for site or nonsite decision making. For example, let us say that a sample of unknown origin is found to contain charred material. The presence of this component, based on the 31 samples, has 69% likelihood of indicating that the sample is from a site only if the charred material were present in the 20-mesh fraction. This would not be very conclusive. If, however, the charcoal were present along with bone, then the likelihood that the presence of these two components together indicated a site would be 88%. These figures suggest that the sample should be considered a possible site sample and further investigation should be pursued utilizing other criteria.

The Chi-square test and percentages in Table 4-7 show that among the numerous components analyzed, only the presence of bone, or a combination of bone and charred material, fairly consistently separates site from nonsite environments.

Discriminant Analysis: In an additional effort to characterize differences between site and off-site samples, the point count data were subjected to discriminant analysis. Discriminant analysis is a quantitative technique for statistically characterizing the differences between two or more groups based on a set of variables. The "mathematical objective" of discriminant analysis is "to weight and linearly combine the discriminating variables in some fashion so that the groups are forced to be as statistically distinct as possible" (Klecka 1975:435). The combinations of weighted variables, which maximize the separation of the groups, are known as discriminant functions. The selection of the groups and the variables to be used in discriminant analysis is defined by the specific research situation.

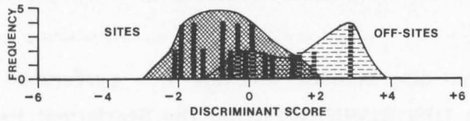
Discriminant analysis was selected for use in this study for a variety of reasons. The analysis aspect of the technique provides several useful tools for interpreting data, including statistical tests for measuring the success with which the selected variables discriminate between groups. This aspect of discriminant analysis is similar in many ways to factor analysis and multiple regression (Klecka 1975:436). An additional use of discriminant analysis is as a classification technique. Once satisfactory discriminating variables have been identified, these can be used to classify new cases with unknown membership. It is this feature of discriminant analysis which can prove useful in the analysis and classification of samples from unknown sources.

The discriminant analysis was performed using program DISCRIMINANT from the Statistical Package for the Social Sciences (SPSS) (Nie et al. 1975). This program allows for the use of either quantitative or qualitative (presence/absence) data and provides for the selection of one of several discriminating algorithms and interpretative statistics.

Two groups were used in the analysis, the on-site set of samples and the off-site set of samples. A separate discriminant analysis was conducted on the results of the point count analysis for each of the 10, 20, 60, and 100 fractions. Additionally, discriminant analysis using presence/absence data was performed on the 10 and 20 fractions (Figure 4-4). Interestingly, it was found that the use of qualitative presence/absence data in the analysis generally produced better discrimination than did the quantitative data. This suggests that the time-consuming process involved in the point count analysis may not be necessary in the analysis of future samples.

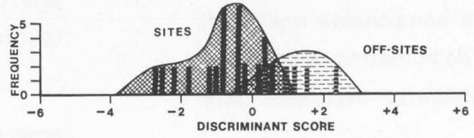
The variables selected for use in the analysis were those which appeared to be most useful in the group discrimination. Because different items were present or identifiable in different screen sizes, the variable list had to be tailored for each size fraction analyzed.

10 FRACTION
QUANTITATIVE
DIRECT METHOD



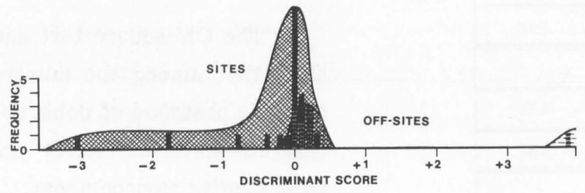
ACTUAL GROUP	NO. OF CASES	PREDICTED GROUP MEMBERSHIP	
		SITE	OFF-SITE
SITE	21	18 85.7%	3 14.3%
OFF-SITE	10	2 20.0%	8 80.0%
PERCENT OF "GROUPED" CASES CORRECTLY CLASSIFIED: 83.87%			

20 FRACTION
QUANTITATIVE
DIRECT METHOD



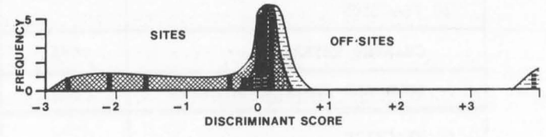
ACTUAL GROUP	NO. OF CASES	PREDICTED GROUP MEMBERSHIP	
		SITE	OFF-SITE
SITE	21	14 66.7%	7 33.3%
OFF-SITE	10	0 0.0%	10 100.0%
PERCENT OF "GROUPED" CASES CORRECTLY CLASSIFIED: 77.42%			

60 FRACTION
QUANTITATIVE
MAHALONOBIS METHOD



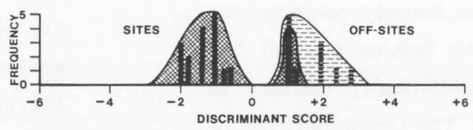
ACTUAL GROUP	NO. OF CASES	PREDICTED GROUP MEMBERSHIP	
		SITE	OFF-SITE
SITE	21	20 95.2%	1 4.8%
OFF-SITE	10	5 50.0%	5 50.0%
PERCENT OF "GROUPED" CASES CORRECTLY CLASSIFIED: 80.65%			

100 FRACTION
QUANTITATIVE
MAHALONOBIS METHOD



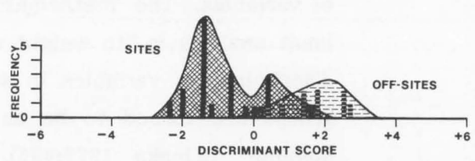
ACTUAL GROUP	NO. OF CASES	PREDICTED GROUP MEMBERSHIP	
		SITE	OFF-SITE
SITE	21	16 76.2%	5 23.8%
OFF-SITE	10	3 30.0%	7 70.0%
PERCENT OF "GROUPED" CASES CORRECTLY CLASSIFIED: 74.19%			

10 FRACTION
QUALITATIVE
DIRECT METHOD



ACTUAL GROUP	NO. OF CASES	PREDICTED GROUP MEMBERSHIP	
		SITE	OFF-SITE
SITE	21	16 76.2%	5 23.8%
OFF-SITE	10	0 0.0%	10 100.0%
PERCENT OF "GROUPED" CASES CORRECTLY CLASSIFIED: 83.87%			

20 FRACTION
QUALITATIVE
DIRECT METHOD



ACTUAL GROUP	NO. OF CASES	PREDICTED GROUP MEMBERSHIP	
		SITE	OFF-SITE
SITE	21	17 81.0%	4 19.0%
OFF-SITE	10	1 10.0%	9 90.0%
PERCENT OF "GROUPED" CASES CORRECTLY CLASSIFIED: 83.87%			

Legend

ON-SITE SAMPLE
OFF-SITE SAMPLE
ON-SITE GROUP
OFF-SITE GROUP

Figure 4-4. *Results of discriminant analysis of point counts using quantitative and qualitative data.*

Both stepwise and direct discriminant analysis methods were performed on the data. (See Nie et al. 1974 for a comprehensive discussion of these methods.) Only the techniques which provided optimum discrimination between the on-site and off-site samples are discussed.

The "direct method" using presence/absence data produced the best results in the 10 and 20 fractions, correctly classifying 83.87% of the cases. The direct method is a technique which considers all variables in the analysis simultaneously. All-group histograms which visually display the spatial relationship of cases and groups as derived in this analysis and the classification results of the analysis are shown in Figure 4-4.

Program DISCRIMINANT provides information on the relative importance of any variable as a discriminator in several ways. The coefficient value of each variable in the canonical discriminant function has in the past been used to rate the relative importance of individual variables in the function. Recent versions of the program have included the production of a discriminant function which provides for each variable included in the function: the pooled-within-groups correlation between the canonical discriminant function and the discriminating variables. The magnitude of the correlation value produced for each variable is a measure of the contribution of that variable to the discriminant function as a whole. The values provided by this statistic fit a prior assumption about the relative importance of particular variables and were used in all of the discriminant analyses to interpret the relative importance of particular variables.

In the 10 fraction, the analysis weighted bone, brackish water clam (Rangia) shell, and unidentified shell as the best indicators of the site group. In every instance, the misclassification of a site (N=5) was due to the absence of bone at the site.

The variables which weighted most heavily in the discriminant function produced in the analysis of the 20 fraction were charred material, land snails, and bone. Four on-site samples and one off-site sample were misclassified in this analysis. However, there is considerable overlap between the distributions of the on-site and off-site discriminant scores (Figure 4-4). Only one site, 41 GV 1, falls well within the wrong group, the other misclassified cases fall in the overlap area.

Quantitative (point count) data using Mahalonobis distance produced the best results in the analysis of the 60 and 100 fractions. This analysis employs a step-wise technique which uses Mahalonobis distance (D squared) as the discriminating statistic. This technique correctly classified 80.65% of the 60 fraction cases and 74.19% of those in the 100 fraction (Figure 4-4). Vegetal material, bone, and charred material were identified as the important discriminating variables.

In both size fractions, there is considerable overlap in the discriminant score distributions (Figure 4-4), suggesting that on-site/off-site differences become less distinct at these smaller size fractions. It is interesting to note that in the 60 fraction, only one site was misclassified, this again was site 41 GV 1. Five sites, including 41 GV 1, were misclassified in the 100 fraction. The consistent misclassification of site 41 GV 1 supports the contention mentioned earlier that, due to the disturbed condition at the site, the sample taken here may not represent cultural deposits.

The comparison of all sites to all off-sites through discriminant analyses demonstrates that if no other information is known about a sample (such as what kind of a natural environment it is believed to derive from), then the presence of bone and/or charred material in the 20 fraction and bone and/or Rangia shell in the 10 fraction are indicative that the sample is cultural. This is essentially the same conclusion reached by the Chi-square analysis. In addition, the discriminant function analysis weighted land snails as a significant site indicator in the 20 fraction, a result which seems reasonable.

An important, and felicitous, conclusion derived from the analysis is that the simplest approach, qualitative (presence/absence) analysis of the contents of the large size fractions, is the most informative. This should certainly facilitate future work.

Objective comparisons between the results of the analysis of the box core samples and the off-site samples were limited to 1) chi-square tests to determine if the distribution of certain components in the point count analysis was significantly different between sites and nonsites than would be expected by chance, and 2) a computer-run, discriminant function analysis to determine to what degree the nonartifactual components in the samples could be used to objectively discriminate between sites and nonsites. Both tests helped pinpoint those components of the samples which were the most sensitive indicators of "siteness." The discriminant function analysis addressed the important question of whether or not the point count analysis can actually be used to tell sites from nonsites and how accurate it can be expected to be. The affirmative answer to this question, in combination with the results of the various other analyses, offers hope that the overall method indeed will be useful in continental shelf archaeology.

geochemical analysis

The geochemical analysis was the most complex analysis applied to the samples. On-site and off-site samples from only five of the 15 sites were submitted for geochemical analysis, so it is unknown how the remaining 10 sites will fare, but the results from these five sites are encouraging. The objective of the chemical analysis was to determine which geochemical constituents or arrangement of constituents in a core sample are most indicative of past human occupation. Based on prior information, the parameters which were considered most important include phosphate, nitrogen, carbon, and selected heavy metals.

The first step was to determine the most suitable grain size for subsequent analysis. Two grain size fractions were separated from a bulk dry soil sample derived from on-site box core samples and off-site (landform) samples. These two size fractions were the less than 200-mesh fraction and the 60/140-mesh fractions. Prior to sieving, each bulk sample was gently ground to crumble large particles from the on-site and off-site locations. The results indicated that the smaller grain size yielded more consistent values for total Kjeldahl nitrogen.

Heavy metals were determined by the methods described in U.S. Environmental Protection Agency (EPA) (1979). Initially, 0.5 gm of prepared solid was digested with a mixture of hot HNO_3, H_2SO_4, and $HClO_4$ acids. This was followed by appropriate dilution and analysis by atomic absorption spectroscopy. Results are reported as parts per million (ppm) dry weight (Table 4-8).

	Total Organic Carbon %	Total Kjeldahl Nitrogen %	Zn (ppm)	Fe (ppm)	Mn (ppm)	Cu (ppm)	P_1 Weakly Bound Phosphates (ppm)	P_2 Moderately Bound Phosphates (ppm)	P_3 Tightly Bound Phosphates (ppm)	P_4 Total Phosphates (ppm)	C/N	Fe/Mn
ON-SITE												
16 SB 49	1.88	.28	36	6550	81	9	308	93	155	556	6.8	80.6
16 VM 7,8	2.39	.31	94	1975	632	10	177	168	636	980	7.6	19.0
16 LF 4	3.39	.30	44	1500	480	7	459	361	3078	3898	11.4	24.0
22 HA 500	7.22	.33	86	7888	988	16	397	448	6000	6845	22.0	8.0
41 GV 66	2.50	1.73	30	4925	594	8	363	351	1183	1896	1.5	8.3
OFF-SITE												
16 SB 49	3.17	.51	29	5833	47	11	175	21	40	237	6.3	123.9
16 VM 7,8	4.10	.68	33	12292	4838	10	243	158	815	1216	6.0	2.5
16 LF 4	9.34	.60	28	12340	266	12	298	56	149	503	15.8	74.8
22 HA 500	1.37	.13	8	9288	59	1	488	73	13	574	11.0	156.4
41 GV 66	.79	.67	25	4525	272	8	144	163	651	958	1.2	16.6

Table 4-8. *Summary of geochemical analysis results by sample.*

Total Kjeldahl nitrogen was also determined by the method described in EPA (1979). The sample was heated in the presence of concentrated sulfuric acid and Kjeldahl catalyst until the solution was colorless or pale yellow. This was followed, in order, by dilution, distillation, Nesslerization, and colorimetric analysis. Results are reported as weight percent total Kjeldahl nitrogen (Table 4-8).

To remove carbonates, soil samples were acidified with 6NHCl for 12 hours, then filtered, water-washed, and dried. A 250 mg subsample was analyzed using a LECO radiofrequency furnace and reported as weight percent organic carbon.

The general procedures used for leachable phosphate are described by Woods (1977). However, several modifications were made to these procedures because of the organic-rich content of most solid extracts. First, the procedure for color development was not applicable. Thus, prior to color development, fractions 1 and 2 were digested using procedures described for total Kjeldahl nitrogen analysis. Second, the phosphate fractions described by Woods as 1) Al/Fe-P and 2) solution CB were combined to form fraction 1 reported here. The three fractions of soluble phosphate reported were 1) NaOH/CB, 2) CBD, and 3) HCl. This order also represents an increasing degree of phosphate extraction.

The results from the geochemical analysis of on-site and off-site samples from the five sites tested are summarized in Table 4-8. A geological framework is essential for the interpretation of geochemical data associated with archaeological soils. For example, a specific grain size fraction must be chosen for analysis throughout. The analyses conducted here indicate that soil grains smaller than 200-mesh provide the most consistent and thus the most revealing data.

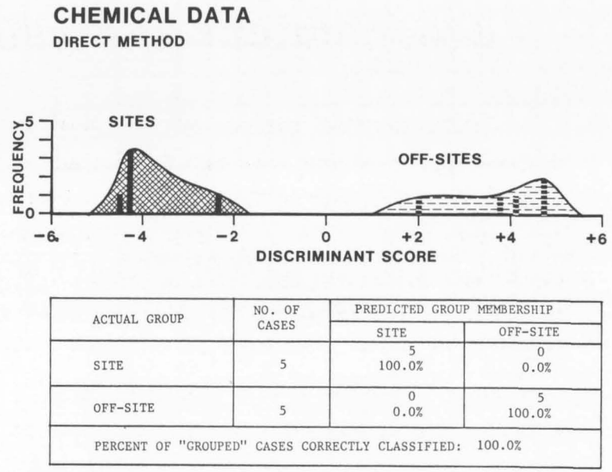
Heavy metal analysis demonstrated that manganese (Mn) and zinc (Zn) are enriched in coastal archaeological soils. When normalized to iron (Fe) content (which should be fairly representative throughout a natural setting), the enrichment of Mn is even more apparent. Zn is concentrated in tissue organisms, especially of fish and shellfish, probably accounting for the Zn enrichment in coastal site soils.

Total phosphate and fraction 3 phosphate are consistently higher in on-site soil samples. This is presumably a result of calcium-bound phosphate which is a major component of bone. Woods (1977) found, by contrast, that most of the phosphates in the archaeological sites he analyzed were loosely bound phosphates while noncultural soils contained primarily tightly bound phosphates (concluding, therefore, that loosely bound phosphates were better for distinguishing a site from a nonsite situation). This was perhaps due to the more sheltered location of at least one of his archaeological sites (a medieval burial), allowing less leaching of loosely bound phosphates. The other site situations are not described. On the other hand, the difference may be due to some discrepancy in formation processes between Woods' sites and the coastal middens used in this study.

In offshore subaqueous sediments, where hydrographic surveys have indicated locations of a potential archaeological site, core samples should be taken and analyzed for heavy metals and orthophosphate as suggested here. However, it is recommended that total Kjeldahl nitrogen and total organic carbon be analyzed as supplemental data since regional variability in these parameters is much smaller offshore than on land. In addition, it is recommended that x-ray diffraction, total carbonate, and the carbon isotope ratio of the total carbonate be included in a geochemical analysis program. These would provide a more complete picture of the influence of man on natural systems, especially in offshore situations, than is provided by the techniques used here.

Discriminant analysis was run on the data resulting from the geochemical analysis of the five on-site and five off-site samples. The direct method classified all of the cases correctly and the all-groups histogram indicates that the two sets of samples are quite distinct (Figure 4-5). The analysis indicated that the most important discriminating variables were (in order of importance):

1) tightly bound phosphates (P_3),
2) total phosphates,
3) moderately bound phosphates,
4) zinc (ppm), and
5) the ratio of iron to manganese (Fe/Mn).



ACTUAL GROUP	NO. OF CASES	PREDICTED GROUP MEMBERSHIP	
		SITE	OFF-SITE
SITE	5	5 100.0%	0 0.0%
OFF-SITE	5	0 0.0%	5 100.0%
PERCENT OF "GROUPED" CASES CORRECTLY CLASSIFIED: 100.0%			

Legend

ON-SITE SAMPLE
OFF-SITE SAMPLE
ON-SITE GROUP
OFF-SITE GROUP

Figure 4-5. *Results of discriminant analysis of geochemical data from five locales.*

These variables appear to be logical discriminators considering the assumptions about the content of archaeological sites and the overall results of the chemical analysis. They also confirm the subjective interpretation of the results.

The discriminant analysis on chemical data must be viewed with some caution because of the small sample size. Some of the most difficult to distinguish site samples, based on other analyses, were not included here. However, the 100% classification and the distinctiveness of the two groups when classified suggest the promise of this approach in distinguishing cultural versus noncultural deposits.

CHAPTER V

SUMMARY AND CONCLUSIONS

Archaeological deposits can be preserved on the OCS. All have not been destroyed by wave processes during the Holocene transgression. This is demonstrated by shelf borings showing preserved coastal deposits, such as oyster reefs and peat beds, as well as by onshore archaeological sites which have subsided to below sea level positions and which have been buried by sediment. Site-landform relationships developed in the active shore zone indicate that submerged landforms provide a basis for identifying high-probability areas for drowned site occurrence on the OCS. These relationships show that certain coastal landforms were favored as habitation sites by aboriginal peoples. The identification of similar relict landforms on the OCS suggests that conditions were suitable for habitation at these locations in the past. It is assumed that man has been in the region for at least 20,000 years. If a relict landform, which might have provided a suitable habitation place, is less than 20,000 years old it can be considered to have a high probability for the occurrence of prehistoric sites. Even though the regional geological history of the shelf is still poorly known, the general late Quaternary framework is well enough understood to approximate the time when drowned, relict landforms were active and/or subaerially exposed. Thus, some judgement can be made regarding the age of submerged features and the probability for archaeological associations.

Drowned, relict, terrestrial landforms can be identified with the geophysical instruments presently employed for geological hazard and cultural resources surveys conducted in reference to mineral leasing and pipeline rights-of-way on the Gulf of Mexico OCS. While sedimentary bodies associated with submerged landforms can be interpreted from sub-bottom profile records obtained during conventional surveys, the resolution is generally not sufficient to identify archaeological deposits. Only in rare instances would the deposits be large enough to show some expression on sub-bottom profile records. For example, Figure 5-1 shows a full-scale excerpt from an actual chart of a sub-bottom profiler. The original chart includes features that have been interpreted as a filled channel and bay. Cross sections of three archaeological sites, selected from those investigated in this study, have been superimposed on the chart to provide some indication of their size relative to the scale of the record. It should be emphasized that this is not an actual record of submerged sites, but only a simulation. It also should be emphasized that if large sites are present, and they were crossed by the survey line at an optimum angle, their overall geometry, internal stratification, and relationship to submerged landforms, might identify them as probable sites. However, the survey grid presently employed in the OCS lease blocks provides only a small sample of data for interpretation of conditions within the entire nine-square-mile block. To illustrate this problem, the survey track grid, produced during the course of an actual OCS survey has been superimposed upon the map of an onshore area in southeastern Louisiana where relict landforms and a major archaeo-

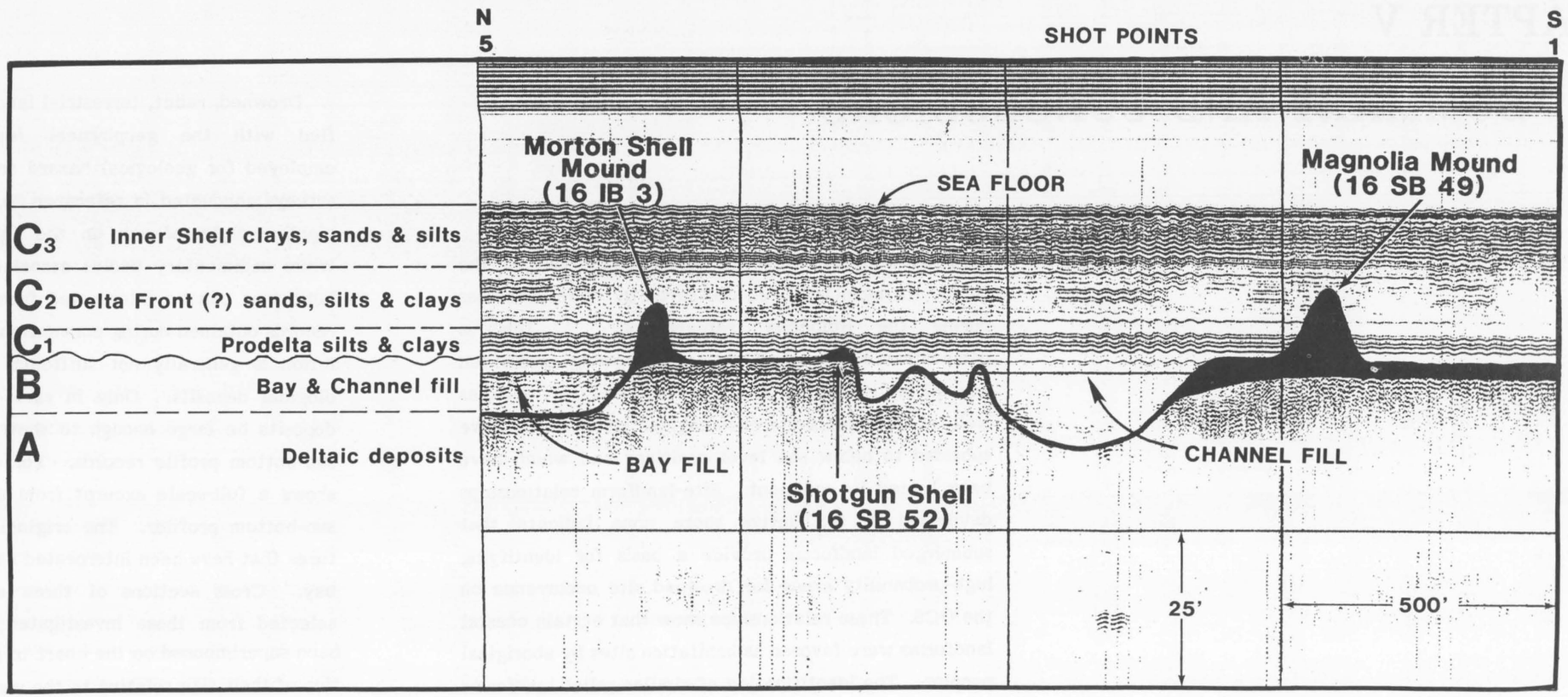


Figure 5-1. *A simulated sub-bottom profile showing hypothesized relationship of archaeological features to geological features. Cross sections of the Morton Shell Mound site, the Shotgun Shell site, and the Magnolia Mound site were superimposed on an actual sub-bottom record of the same scale to produce the simulation.*

logical site have been identified (Figure 5-2). In this case, the Magnolia Mound site (16 SB 49), probably the largest remaining prehistoric archaeological site in coastal Louisiana, is large enough to be caught by the survey grid mesh. The site is crossed by 2 (5.6%) of the survey lines within the lease block. As noted above, even when crossed by a survey track, only under optimal conditions would an archaeological site be identifiable on the sub-bottom profile record. Further, smaller sites, which are more typical, might easily be missed completely by the tracks.

Potential sites can be verified only through physical testing. A variety of devices are available for obtaining cores and core-type samples (McQuillin and Ardus 1977; Bouma 1969). These include gravity corers, box corers, and similar bottom sediment sampling tools. Grab samplers may be used to further delineate site area. However, there is no substitute for an undisturbed core or box sample for verification of a potential submerged site. Systematic analysis of core-type samples provides a basis for verifying or rejecting potential submerged sites with a high degree of certainty.

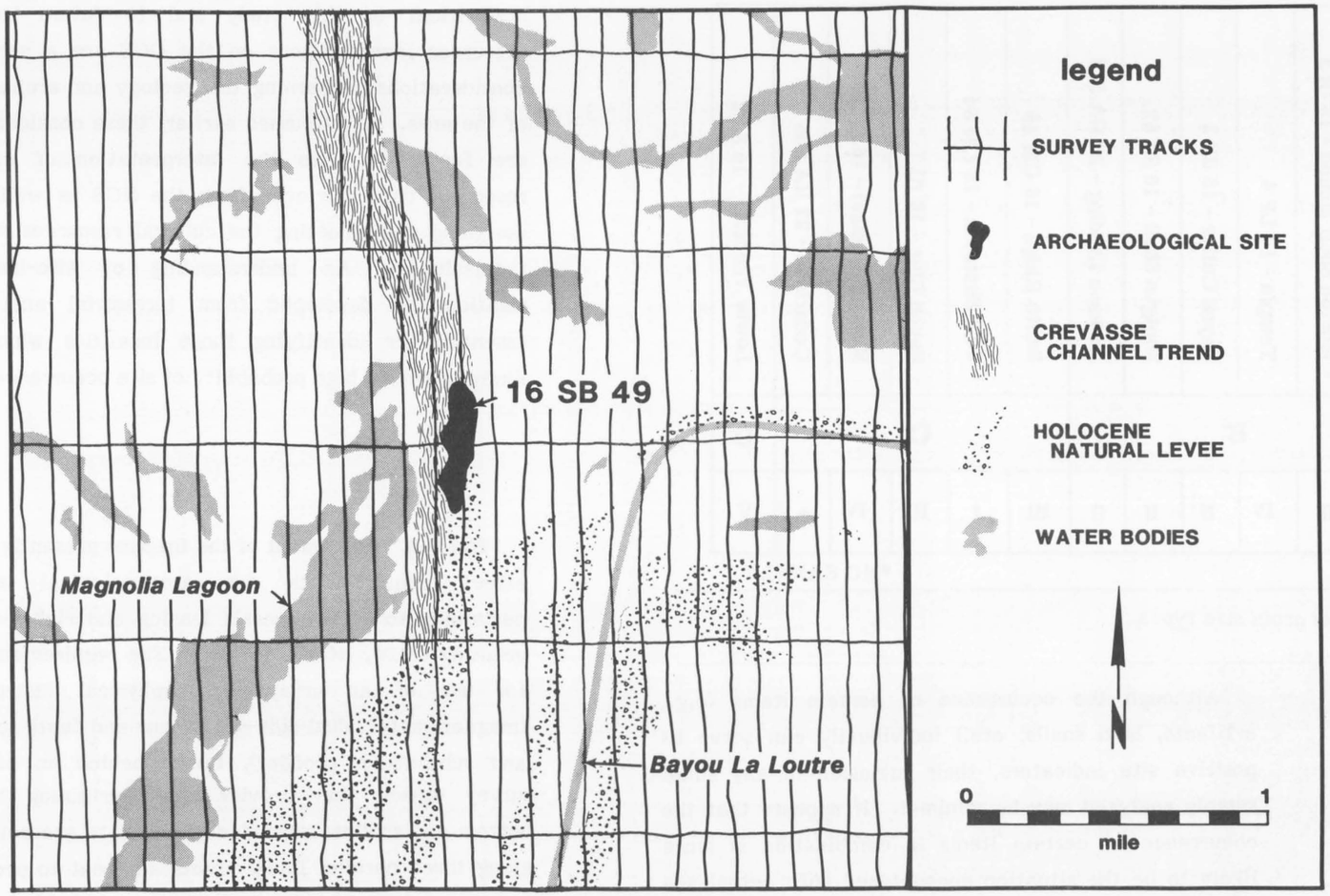


Figure 5-2. Actual survey track grid superimposed over an onshore area comparable in size to a lease block containing a large archaeological site.

A major intent of this report was to develop a formalized and systematic approach to testing potential submerged archaeological deposits. Criteria for identification have been developed using small, core-sized samples commensurate with the size of sample which would be available to the archaeologist for analysis. The report itself has been designed and compiled to serve as a guide to analytical procedure such that the researcher can begin analysis at the grossest level of examination of general core lithology and proceed, as necessary, through macro- and micro-sedimentology, and finally to the level of geochemical analysis. The findings suggest that a sample derived from a cultural deposit has a high likelihood of being identified as such prior to reaching the need for geochemical analysis.

Although the characterization of archaeological deposits was a major intent of this study, it has been demonstrated that certain analytical procedures are more useful than others in their identification. The grain size analysis showed considerable variability across sites and landforms and was only successful in distinguishing sites when they occurred on natural levees. As noted, this is related to the fact that cultural forces seem to introduce mid- to large-sized artifactual and nonartifactual particles which would contrast with such fine-grained deposits as natural levees. Grain size analysis appears less useful at site identification where landforms are composed mainly of greater-than-sand-sized particles. Continued use and refinement of grain size analysis may enhance their utility as descriptive and explanatory techniques in a variety of terrestrial, as well as submerged, archaeological situations.

As shown in Table 5-1, there is some correspondence between sample groupings based on macro-sedimentary parameters and those based on grain size distributions. As can be seen in the table, all of the samples in Category A (bedded sand and marine shell) consist of well-sorted sands of the barrier island and beach ridge type. Category B (Rangia shell) includes grain size types from two groups: II (exclusively from massive Rangia shell sites) and IV (miscellaneous). Category C (sand, silt, and clay with inclusions), as might be expected, shows the greatest range of variation in size

	Mitchell Ridge - 41 GV 66	Caplen - 41 GV 1	Veazey - 16 VM 7, 8	Pierre Clement - 16 CM 47	Morton Shell Mound - 16 IB 3	Temple - 16 LF 4	Bayou Cutler - 16 JE 3	Shotgun Shell - 16 SB 52	Jackson Landing - 22 HA 500	Smith Ridge - 16 CM 49	Jeff Simmons - 16 CM 84	Bayou Blue - 16 Al 1	Magnolia Mound - 16 SB 49	Cedarland - 22 HA 506	Lower Vacherie - 16 SJ 2
MACRO-PARAMETER CATEGORIES	**A**			**B**						**C**					**D**
GRAIN SIZE TYPES	I	I	I	IV	II	IV	II	II	II	III	I	III	IV	*	IV

*NO SAMPLE

Table 5-1. *Comparison of macro-parameter categories and grain size types.*

distributions, with types I, III, and IV represented. The grain size distribution of the sample from Category D is distinctive from the curves of all other samples. It can be concluded that there is generally a good relationship between categories of samples based on macro-sedimentary parameters and those based on grain-size distributions.

The point count analysis appears to be the most useful of the techniques used, in terms of results and practicality. The smallest-sized fractions (60, 100, and pan) are time-consuming to process and analyze, limiting their usefulness. The statistical reliability of the two largest-sized fractions (10 and 20) in yielding positive site identification, suggests that in most cases there will be no need to proceed to analysis of the smaller-sized fractions.

Although the occurrence of certain items (e.g., artifacts, land snails, etc.) individually can serve as positive site indicators, their inclusion in any small sample analyzed may be minimal. It appears that the occurrence of certain items in combination is more likely to be the situation encountered with actual sea floor samples.

Because only a small number of samples was submitted to statistical treatment, the results must be viewed with caution. They do suggest, however, that certain items, specifically bone or a combination of bone and charred material, consistently separate site from nonsite samples. The results of the discriminant analysis are seen as supportive of both the utility of point count analysis in the assessment of core samples and in its reliability in distinguishing sites from nonsites.

Critical to this study and to future cultural resources investigations on the OCS are a series of considerations concerning the geology and archaeology of the area. As discussed earlier, these considerations are fundamental to the interpretation of cultural resources data retrieved from the OCS as well as in designing and directing the cultural resources surveys themselves. An understanding of site-landform relationships developed from terrestrial analogs is essential for identifying those localities which are likely to have a high probability of site occurrence.

The U.S. Department of the Interior presently has in effect requirements for archaeological surveys pertaining to OCS minerals leasing and rights-of-way granting (BLM, NO OCS 1981). The requirements call for use of an array of geophysical instruments (magnetometer, dual side-scan sonar and depth sounder, and sub-bottom profiler), towed behind an offshore survey vessel, that provide data pertaining to the bottom and shallow subsurface. The data are collected along three parallel linear tracts adjacent to proposed pipeline rights-of-way or in a grid pattern in lease block areas (see Figure 5-2) and proposed platform locations. Continuous electronic positioning equipment is utilized during the surveys, and the data are interpreted by a marine survey archaeologist. The purpose of these surveys is to identify cultural resources in order to prevent inadvertent damage or destruction. Thus, the basic goal of the program is avoidance. This is an important distinction to make, as there is presently no serious program operative in the Gulf of Mexico whose basic goal is discovery and study of submerged prehistoric sites.

It is apparent that the goal of avoidance is achievable within present technological capabilities. If there is a shortcoming in the archaeological survey program, it is in the area of application and decision making. The application of an ordered and consistent scheme of decision making would substantially contribute to the utility of the program. A diagram of decision making which will lead to successful avoidance is presented as Figure 5-3.

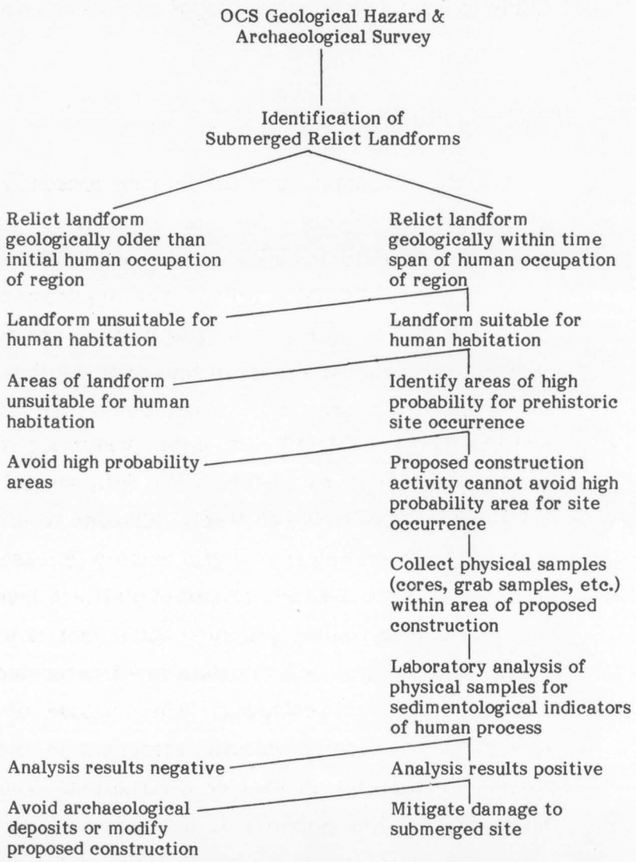

OCS Geological Hazard & Archaeological Survey
Identification of Submerged Relict Landforms
Relict landform geologically older than initial human occupation of region
Relict landform geologically within time span of human occupation of region
Landform unsuitable for human habitation
Landform suitable for human habitation
Areas of landform unsuitable for human habitation
Identify areas of high probability for prehistoric site occurrence
Avoid high probability areas
Proposed construction activity cannot avoid high probability area for site occurrence
Collect physical samples (cores, grab samples, etc.) within area of proposed construction
Laboratory analysis of physical samples for sedimentological indicators of human process
Analysis results negative
Analysis results positive
Avoid archaeological deposits or modify proposed construction
Mitigate damage to submerged site

Figure 5-3. Decision-making tree for identification of submerged OCS terrestrial archaeological sites, for purposes of avoidence.

Avoidance can, of course, be achieved without site identification by simply staying away from high probabilty landforms. Such a course of action is not always practical or efficient and site verification employing the approach presented here is likely to be a critical step in the decision-making process.

The present study was conducted in response to problems of discovery and verification of submerged sites related to the Department of Interior surveys in conjunction with minerals leasing and rights-of-way granting. However, the findings have equal application to possible future research programs directed toward learning more about the prehistoric cultural resources of the continental shelf. The tools for such research are the same as those required in conducting cultural resources surveys. Because of differences in goals, however, the application of techniques will vary. Table 5-2 presents a series of tasks which, it is felt, can be successfully applied to cultural resources research on the OCS. The present study has been directed at filling a major gap in the ability to locate and identify submerged archaeological sites. It is hoped that this contribution to existing method, theory, and technology will substantially increase the ability to locate, identify, and study the cultural resources of the OCS.

1. Synthesize geophysical and geological data from OCS geological hazard and archaeological surveys, from the literature and other archival sources.
2. Identify areas with well-defined, submerged, relict landforms and thin marine sediment cover.
3. Identify relict landforms geologically within time span of human occupation of region.
4. Identify areas of high probability for prehistoric site occurrence.
5. Conduct tight-grid geophysical survey designed for optimum scale and resolution to define archaeological deposits. Collect an array of physical samples in conjunction with survey.
6. Analyze geophysical data and physical samples for site indicators and test discovered sites using large volume box core samples.

Table 5-2. Tasks for identification and discovery of submerged OCS terrestrial archaeological sites, for purposes of definition and study of cultural resources.

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